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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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The Potentialities of Rustless Iron.

Rustless iron must not be confused with stainless steel, as its properties and industrial applications differ considerably.

Stainless steel is now universally known and recognised in its application to the cutlery industry, and also in a much smaller degree to the engineering trades—valves, pump rods, spindles, turbine blades and numerous other articles now being manufactured. It is somewhat limited in its sphere of usefulness on account of difficulties met with in forging and working due to its nature. It requires constant heat treatment, and must finally be tempered, and then polished to render it stainless.

Rustless iron is a further development, being discovered about the beginning of the war, which interfered with its expansion. It does not require heat treatment after it is made into the ingot, and is exceedingly ductile in working up into manufactured articles.

Its commercial practicability having been now fully established, stainless metallurgy has now become an absorbing topic among steel manufacturers. Considerable experimenting has been, and is being, undertaken, with the result that a point has now been reached which increases its sphere of usefulness to an almost incredible extent. The newer material is really a dead soft steel, from which the carbon has been practically eliminated, and which, for classification purposes, has come to be known as "Rustless Iron," to distinguish it from its harder relation, "Stainless Steel."

Both these steels represent a new chapter in the romance of Sheffield's industry, and are not considered to be more important than the advent of tungsten high-speed steels.

Rustless iron presents a number of initial difficulties, the elimination of carbon being one, and its manufacture is one calling for minute care and attention in all stages. Careful supervision of the raw materials, and also in the melting, in order to keep down the carbon content, means high-class laboratories and skilled chemists.

It is being made in crucible pots, both coke-fired and gas-fired, but the electric furnace method is by far the most satisfactory for controlling the carbon content, and at the same time keeping costs within commercial bounds.

The usual process is to melt the steel scrap, decarbonise, and then add carbon-free ferro-chrome. Owing to reactions which take place, it is very difficult to eliminate carbon after the chrome is added.

It is, however, being made direct from chrome ore in the electric furnace, by a combination of "Thermit" reaction, supplemented by electrical energy. Comparative physical tests are stated to favour the use of carbon-free ferro-chrome.

Rustless iron contains 10-12 per cent. chromium and a carbon under 0.1 per cent. maximum, with the balance as nearly as possible pure iron. Stainless steel contains about 14 per cent. chromium, and a cheaper grade of ferro-chrome can be used. The former, however, compares very favourably in price with the finished sheet or bar through lower working costs after casting. Easier working and the dispensing of heating costs should make rustless iron a strong competitor of brass and aluminium, when due regard is taken of its rust-resisting properties when exposed to ordinary atmospheric conditions, and its subsequent labour-saving qualities, especially in articles of domestic utility. A damp cloth wiped over any article made of rustless iron will remove any dirt which may have settled on it, and leave a perfectly clear surface. There is no necessity to lacquer as in brass, and nickel-plate, or galvanise as in mild steel, and therefore such expenses are eliminated.

With regard to its physical side, rustless iron is at least twice as strong as brass, and much tougher than common iron, and much can be done, therefore, to cut costs in weight saving in the manufactured article. It has a tensile strength of 30 to 40 tons per square inch, and even higher with special treatment, and yet can easily be stamped, pressed, rolled or drawn in a cold state. It can also be soldered, brazed or electrically welded, and machines easily. It can be chased or engraved as well as burnished equal to plate.

So far as present prices are concerned, rustless iron is more expensive than brass, and a little higher than aluminium sheet, but if produced in bulk should compare more than favourably with such materials, in addition to its special properties.

XUM

When one comes to consider its uses, it is difficult to know where to begin, as the naming of one article immediately suggests a dozen others. Anything made from brass, sheet, rod or tube can be made from rustless iron, and articles of domestic utility present a wide field. The stove grate industry, cooking ranges, cabinet fittings, railway carriage and tram fittings, the motor trade, refrigerating plant, ship work, etc., can all absorb huge quantities.

Sheffield manufacturers are preparing for big developments, and it is now possible to obtain sheet, rods, wire and tubes in rustless iron quickly. At present castings cannot be made, as the metal is very sluggish in pouring, even with a high temperature.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Portable Receivers.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—About 25 years ago I first worked in conjunction with the trolley floor track introduced to lighten the labour of metal-carrying. Then came the overhead trolley track, but with these tracks, when used in light iron foundries, there is a larger percentage of wasters than in smaller foundries where metal is brought direct from the furnace.

The mode of distribution is often as follows:—About 16 ladles are awaiting their turn at the furnace, they are usually black cold. When filled, a ladle is transmitted to the point of distribution, where spilling occurs through the drop of about 3 or 4 ft. into the shanks, which mixes the dirt, etc., with the body of metal received. As a general rule, the metal is not sufficiently fluid for the moulder using it to wait for the slag floating to the top of his ladle, and the dirt that does appear comes up in small patches, and refuses to knit into a compact mass at the centre of the ladle, as it does when the metal is direct hand-carried from the furnace. The wasters made by this system do not end in the foundry, and a large number are picked out after costly machining operations.

To overcome the above failure for light iron foundries it is useless to install a plant with about 16 overhead lines in a shop 60 × 100 yds. in such a manner as to prevent the ladles colliding. It is preferable to place one line down the middle, and two lines centred between the wall and the middle lines, as this should be sufficient for the economic distribution of the metal.

It is generally conceded that receivers to a furnace are beneficial, and a portable receiver should commend itself; such receivers should be about 1-ton capacity, similar to an ordinary ladle, with an additional tapping spout at the bottom, and covered-in top.

The number of receivers used would obviously depend on the capacity of the furnace. Receivers must not be kept waiting for refilling, in order to preserve their heat.

Each receiver would require two men, but the system would eliminate much labour and time lost through ladles waiting and the confusion thus caused. As the receivers are adaptable to any cupola, no heavy charges would be incurred.—Yours, etc.,

T. D.

November 21, 1921.

Foundry Managers and the British Cast Iron Research Association.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—A large number of letters have been received from foundry managers, foremen, etc., asking us whether they are eligible for membership of the B.C.I.R.A. As there is a widespread feeling that some information should be given upon this point I should be glad to have the assistance of your columns.

The associate class of membership has been specially arranged to allow foundry and works' managers, foremen, chemists, scientific workers, or anyone connected with the cast iron or allied trades to join the Association. The subscription of 30s. per annum is a low one, and the Associate has very valuable privileges.

He can use the Technical Bureau to obtain any foundry data or information he requires, he can borrow any technical journal, paper, or book from the Library, and he will receive the monthly bulletin containing the abstracted data from all the world's technical journals.

A number of Associates have already joined, and the Council intend to make this class of membership a valuable one, as it will enable an Associate to keep himself thoroughly up-to-date in foundry work.—Yours, etc..

THOS. VICKERS,
Secretary

Central House, New Street, Birmingham.

Some Perplexing Foundry Problems.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I read the discussion on my Paper at the London Branch meeting with great interest, but at the same time I would again point out that most of the speakers never attempted to answer the questions at issue.

In no part of the Paper is mixing by fracture advocated. It is distinctly stated "That no one sets a higher value on the use of chemical analysis than the author." I take it our object is to produce regularly an iron that will give a high test-result. Now, the "ultimate" chemical composition of this iron is roughly known to most of us. How is it, then, that whilst working off certain stacks of iron, we obtain regularly about 17 tons tensile; when one or more of these stacks are exhausted and others substituted, the test often drops to about 13 tons, yet in both cases the ultimate analysis is the same. Or, to carry Mr. Lambert's rabbit analogy a step further: Can he, or anyone, by knowing the ultimate, constitutional, or any other analysis of his pair of rabbits, predict, with certainty, the sex of the unborn progeny of these animals? That is the crux of the question. If it is possible by any examination of the iron previous to melting to guarantee the maximum test in the resultant cast bar, the problem is solved, and we can with safety reduce the weight of most of our castings by 25 per cent., and produce the required calculated strength.

I note, also, Mr. Cole Estep's remarks *re* American practice. May I suggest to him that chemical analysis was to some extent forced on his countrymen by the lack of experienced foundrymen to keep pace with the rapid growth of the number of foundries, and that some "fool proof" method had to be advocated to meet this want. In any case, if a "Standard Test" of 9 tons per square inch is the best a universal use of chemical analysis can give them, it is no great recommendation. Yours, etc.,

J. SHAW.

Brightside Foundry, Sheffield,
November 27.

The International Foundry Trade Exhibition.

It has been thought by some that the statement made in November 17 issue of THE FOUNDRY TRADE JOURNAL that all the available space at Bingley Hall has been applied for, meant that it is useless for prospective exhibitors to approach the secretary of the Exhibition Committee, who has his offices in the Chamber of Commerce, New Street, Birmingham. Such an impression is quite erroneous, as *no allocations have yet been made.* This is readily understandable, as it is the desire of all concerned with the Exhibition to make it as thoroughly representative of the foundry trades as possible.

Forthcoming Events.

Institution of British Foundrymen.

Scottish Branch (Glasgow Section):—Open meeting for the discussion of foundry problems, on December 10.
Scottish Branch (Falkirk Section):—"Fluid Cast Iron," by M. Riddell, on December 17.
Birmingham Branch:—"Development of the Cast-iron Industry," by J. Newton Friend, on December 10.
Newcastle-on-Tyne Branch:—"Semi-steel and other subjects," by — McLain, on December 10.
Lancashire Branch:—"Jar Ram Moulding Machines," on December 3.
Lancashire Branch (Burnley Section):—"Foundry Problems," by W. H. Cook, on December 6.
London and District Branch:—Joint meeting with the London Branch of the Institute of Metals. "Casting in Metal Moulds," by G. A. Wells, on December 8.

Foundry Costs and Establishment Charges.*

By Daniel Adamson, M.I.Mech.E.

The correct ascertainment of costs is acknowledged to be an important part of manufacturing, and particularly of engineering, and in no part of engineering practice is this question of greater interest than in a foundry.

In a recent address on "Foundry Problems," Lord Weir said that the advances in wages and prices of raw materials during recent years, by accentuating the necessity for increased and more economical production had "elevated the subject of foundry costs to a position of prime importance."

In other operations of engineering the raw material is provided in some finished form, so that it is sufficient to base the cost of the material used upon the market price at which it can be purchased, but in foundries the material has to be converted from a more elementary condition into a usable form with the help of fuel, labour, and power, and the cost of this conversion has a varying effect upon the cost of the finished article according to the amount of material required per piece.

The speaker's object is to endeavour to arrive at a reliable method of estimating the cost of the many varieties of castings in green sand, dry sand or loam, that are produced in the foundry attached to a general engineering business.

When a proposal to introduce a scheme of "payment by results" or "bonus on output" is under consideration, it is essential to have a proper knowledge of current costs to enable reliable calculations to be made as to the probable effect of such schemes upon their ultimate success.

On inquiry amongst his friends, he finds that a very common method is to divide the output of the foundry into light, medium, and heavy castings, without any definite law to guide those responsible for making the division.

It is becoming more usual to take note of the cost of skilled labour employed in making the mould, and as the casting is more intricate, or larger, more moulder's time will be booked to the job. It might appear, therefore, that it would be sufficient to take the value of the skilled labour booked to the job as a basis for the costing operations, but this is not a fair division as between the simpler castings and others of more elaborate design, taking considerably more labour to mould, although, perhaps, of the same weight when cast.

If the skilled labour were to be taken as the basis for the calculations of cost, then the intricate casting would carry more than its due share of establishment charges, because part of these charges is involved in handling raw material, and in melting the same in the cupola, with consequent expenditure of fuel and power. It follows, therefore, that a plain casting would, under the circumstances suggested, come out cheaper than was justified, because the labour cost would be low, while the amount of metal used would be equal to the more expensive casting.

The division of the indirect charges as between the molten metal and the workmanship expended on the mould is a matter to be estimated for each particular establishment. The indirect charges should be ascertained at regular intervals, say every four weeks, and can then be allocated somewhat as follows:—

Unallocated labour: 25 per cent. of this item to be charged to "metal" and 75 per cent. to workmanship account.

Power: 50 per cent. to metal and 50 per cent. to workmanship.

Light: 20 per cent. to metal and 80 per cent. to workmanship.

Foremen's wages: 20 per cent. to metal and 80 per cent. to workmanship.

Clerical charges (including management): 35 per cent. to metal and 65 per cent. to workmanship.

Office expenses: 25 per cent. to metal and 75 per cent. to workmanship.

Maintenance of buildings, machinery, and plant, mill stores and sundries: 25 per cent. to metal and 75 per cent. to workmanship.

Depreciation and obsolescence: 25 per cent. to metal and 75 per cent. to workmanship.

Bank charges: 50 per cent. to metal and 50 per cent. to workmanship.

Rates, taxes and insurance: 15 per cent. to metal and 85 per cent. to workmanship.

When the amounts of the specified items are ascertained over a given period of, say, four weeks, they can be converted into percentages of the totals expended during the period for materials and direct labour respectively, and for the purpose of ascertaining the cost of a particular casting made during that period, the ascertained percentages would be added to the net cost of materials and workmanship respectively, and, in normal times, a further sum to cover contingencies and profit.

The net cost of materials would include the value of everything charged into the cupola, such as pig-iron, scrap, coke, limestone.

The net cost of workmanship should include as much time as can be booked directly to the job, particularly moulders and coremakers, also moulding machine time, and,in some foundries, dressers' time also.

The method suggested would appear to be as arbitrary and empirical as the more common method of dividing castings into light, medium, and heavy, already criticised, but as the respective items are dealt with individually, it is easier to assess them correctly, or, in the event of errors, it may be expected that these will mutually cancel out.

From time to time these arbitrary percentages can be overhauled and adjusted by experience more readily than the less reasoned method.

Since preparing these remarks, a Paper has been presented to the American Society of Mechanical Engineers, by Prof. Bird, of the Worcester Polytechnic Institute, entitled "A Foundry Costing and Accounting System," in which it is suggested that the most important items for costing purposes are (1) moulding labour, (2) core making labour, (3) weight of castings produced.

It is stated, for the particular foundry referred to, that it was found necessary, in 1918, to add 81 per cent. to moulding labour to cover supplies and expenses, and 30 per cent. to coremaking labour to cover materials for this part of the work.

The figures given in the Paper (A.S.M.E Transactions, 1918, page 67) may be summarised as follows:—

Cost of Metal.—75 per cent, of the weight of the castings produced was taken as representing the pig-iron and 37½ per cent. as the scrap iron used, thus apparently allowing 12½ per cent. of net production for losses.

The average price of the pig-iron and scrap is taken as $2.30 per 100 lbs., or £10 14s. per ton of finished castings.

The cost of melting was found to be 30 cents per 100 lbs., or 28s. per ton.

Moulding labour, $1.50 per 100 lbs., or £6 17s. per ton.

Expenses and supplies at 81 per cent. on moulding labour, $1.20 per 100 lbs., or £5 10s. per ton.

Coremaking labour, 38 cents per 100 lbs., or £1 18s. per ton.

Coremaking materials at 30 per cent. of the coremaking labour, say, 12 cents per 100 lbs., or 11s. 6d. per ton.

The total establishment charges are, therefore, £1 8s., plus £5 10s., plus 11s. 6d., or £7 9s. 6d. per ton.

The direct labour is, therefore, £6 17s., plus £1 18s., or £8 15s. per ton.

The average pay per moulder per day was $4, and the production per moulder per day 275 lbs.

In the discussion on this Paper the author of it was strongly criticised because no notice was taken of the cost of cleaning castings, and no attempt was made to distribute equitably the cost of building repairs, power, light, heat, water, depreciation, taxes, insurance, supplies, delivery, and administration, all being lumped together and treated as a percentage of moulding labour only.

* These notes were presented at a meeting of the Manchester Association of Engineers, held on November 25, for the purpose of opening a discussion.

It is of interest, however, to try to compare these American figures with those shown.

In a British example, wherein indirect charges are £4 12s. per ton, against £7 9s. 6d. in the American example, the direct labour £7 10s. per ton, against £8 15s., and the material used £9 per ton, against £10 14s., or the total cost in the example is £21 14s. per ton and in the American example £26 18s. 6d.

The indirect charges are 62 per cent. of the direct labour, while the American example shows the indirect charges are 85 per cent. of the direct labour.

In arriving at the cost of the skilled labour booked directly to the job, and upon which the calculations of cost are to be based, attention should be given to the accuracy of the records made, and the most reliable method appears to be that in which job tickets are issued by the foreman to the workman, who, in turn, stamps these in a time clock at the beginning and end of his time on the order.

By using the clock in this manner remarkable discrepancies in previous records were discovered, and the conclusion arrived at that the usual methods of booking time, whether dependent upon the observation of the foreman, or a clerk, or upon the memory or imagination of the workman, are quite illusory and so unreliable as to be almost useless.

While the job ticket system is of great value in other departments of engineering it is particularly advantageous in a foundry, where it acts also a check upon the quantity of bad castings made.

The question of a suggested period of four weeks has been mentioned, and it is well worth consideration whether the system adopted by Messrs. Hans Renold, Limited, should not be more generally applied to engineering establishments, that is, to divide the year into thirteen periods, each of four weeks, instead of as at present into calendar months. If the calendar month is adopted, it means that in every three months there are two periods of four weeks and one of five weeks, which make it impossible to distribute equitably the costs for the work produced during the period, while to wait for thirteen or twenty-six weeks to elapse before making this distribution introduces an element of delay and uncertainty that is best avoided in the interests of the correct solution of the problem.

It is possible to arrange the internal accounts of an establishment on this basis, but a difficulty at once presents itself when external invoices, either inwards or outwards, are dealt with, and, in the writer's opinion, it would be very much to the advantage of the engineering and allied trades (which are largely interdependent) if a general understanding could be come to for the adoption of the four weeks accountancy period, thirteen to the year.

The whole intention of installing machinery to do what has previously been done by manual labour is to reduce the time occupied by the workman, or to simplify the operation so that less expensive labour can obtain the desired result. The effect upon the cost system is the same in either case, in that the total cost of the direct labour cost it means that the net labour cost the case, the direct labour is the sole basis for the allocation of indirect charges, it means that the installation of an expensive machine, by reducing the direct labour cost, reduces the share of the establishment charges borne by the work done, with the result that work can be going through the shops showing a very low labour cost and accordingly carrying a very small proportion of the establishment charges, and yet, at the same time, the installation of one or more expensive machines has sent up the real indirect costs of the establishment by calling for more ground space, more power, more light, more crane capacity per man employed, and it would only require a few years of development in this direction to affect adversely the profit and loss acount.

It is therefore essential, in the interests of sound finance, when considering a machine of any kind to estimate carefully the extra cost involved in depreciation, wear and tear, tool room equipment, and all the miscellaneous indirect charges of a modern establishment, and so ensure that the work done on the new machine is properly charged for.

The output obtained from a jolt ramming machine is from four to ten times what can be done on similar repetition work by journeymen moulders working in the old way on loose patterns.

If one machine is installed which gives four times the amount of output for the same direct labour cost it means that the direct labour cost is divided up by four, and unless the cost-charging methods are modified accordingly there will only be one-quarter of the previous amount contributed towards establishment charges. To obviate this, it is necessary that the machine be charged at an hourly rate to compensate for this deficiency, otherwise the other work in the foundry still being done by the old-fashioned method will be carrying more than its due share of expense.

The writer has been favoured with the figures of working costs for a period of six months ending December 31, 1920, of an installation of eight jolt rammers, with a 500 cubic feet per minute air compressor supply, also seven air hoists, five riddles and a sand blast plant dealing with 20 tons of castings per day, and believes that these will be of value to members.

The eight moulding machines were as follows:—

Number.	Size.	Power.
1	300 lbs.	.84 h.p.
2	800 lbs.	1.4 h.p.
2	1,120 lbs.	1.67 h.p.
1	1,120 lbs.	1.9 h.p.
2	1,500 lbs.	2.24 h.p.

The average cost of running these machines, allowing 10 per cent. for lost time, was found to be 1s. 3d. per h.p. hour, made up as follows:—Maintenance, 4½d.; power (steam-driven compressor), 4d.; depreciation at 10 per cent. per annum, 3½d.; interest on capital at 7 per cent. per annum, 3d.; total, 1s. 3d. per h.p. hour.*

At 1s. 3d. per h.p. hour the cost of running the eight machines I have mentioned varies from 1s. to 2s. 10d. per hour, and as the wages of a moulder and helper are about 3s. 6d. per hour, it pays to adopt moulding machines on suitable work when the increased output mentioned earlier can be obtained.

If the 10 cwt. of castings were made (by piecework) on a moulding machine in one-eighth of the time the men could double their daywork earnings, and the reduced cost would be as follows:—

	£	s.	d.
Direct labour, including unskilled help, say	1	0	0
Piecework bonus, say	1	0	0
Indirect charges at 46 per cent., as before	0	18	6
Machine time, six hours at, say, 2s. 1d. per hour	0	12	6
Metal as before, at 10s. per cwt. ...	5	0	0
Total	£8	11	0

or £17 2s. 0d. per ton.

In addition to the advantage of increasing the output at reduced cost the castings from moulding machines are better finished, and more true to pattern. With well designed machines and proper patterns it is not necessary for the operators to make any skilled use of moulders' tools, and, in fact, it is found more economical to knock out a damaged mould and try again than to attempt to repair it.

Less dressing, or fettling, is required, and the cost of machining is reduced, because less allowance is required on the pattern, and the castings are more easily "jigged" for machining.

All these remarks show the necessity of a carefully kept costing system in a foundry, so that the advantages of improved methods may be quickly and accurately estimated.

Acknowledgment was made to several firms who have provided some of the information used, namely, Messrs. Ashwell & Nesbit, Limited, Leicester, and Messrs. Rose Downs & Thompson, Limited, Hull; Messrs. The Horsehay Company, Limited, Shropshire; Messrs. Buckley & Taylor, Limited, Oldham; Messrs. The Mirrlees Watson Company, Limited, Glasgow, and others.

* A firm of engineers and ironfounders engaged in the manufacture of electrically driven air compressors state that a reasonable allowance for power would be 1½ K.W. per machine, or, say, 3d. per hour

Belt Pulley Castings.—I.

By Ben. Shaw and James Edgar.

It is not possible to overestimate the importance of pulley design and manufacture. The split wooden-pulley has become very popular in many factories, and has much to commend it, and the direct drive has been adopted in a large number of machine shops, but the innovation has not greatly lessened the demand for cast-iron pulleys. Twenty or thirty years ago the millwright generally designed his own pulley, sometimes in a rough and ready manner, it is true, but they were usually satisfactory nevertheless, based as they were on practical experience. Even now in many small works the patternmaker is called on to design a suitable pulley for a certain purpose, and, if he has not a knowledge of proportion, it is unlikely that the result will be satisfactory. It often happens that when a casting has to be replaced because of some defect, it is used as a pattern for the new casting without any modification being made in order to strengthen it. There is not, however, the same need for craftsmen to have a knowledge of the principles of design as it was at one time, because pulleys, like other things, are usually made nowadays by firms that specialise and can supply from stock. Thus when the patternmaker makes a pulley he generally works from a finished drawing. But the craftsman ought to be able to design pulleys himself; therefore, while this article will be primarily a review of pulley-manufacturing methods for quantity production, it may be worth while briefly to discuss proportions.

The principal parts of a pulley are the rim, the arms or web, and the boss. The rim, which may be shrouded or plain, is made convex in form, in order to keep the belt on the centre, the radius of the curve usually being about three times the width of the pulley.

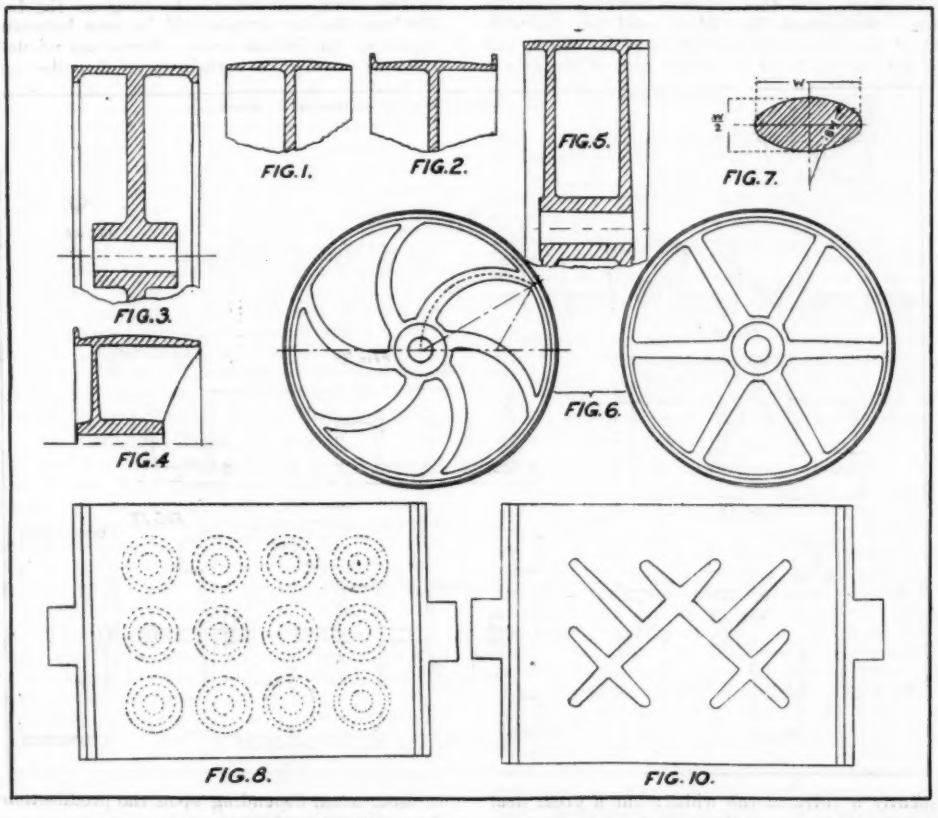
As a rule very small pulleys have solid webs connecting the rims with the bosses, and as the diameters are increased arms are used in the place of webs for lightness. Apart from the very small pulleys which carry a web, it may be accepted as an axiom that small pulleys have straight arms and medium sized and large pulleys curved arms. Really, all pulleys ought to have curved arms to reduce contractional strains, but the arms are so short in small pulleys and the differences in metal thickness are not as considerable as with large pulleys, hence for convenience the arms are made straight.

The arms are generally elliptical in section, the major axis being usually twice that of the minor axis, and they are tapered gradually from the comparatively heavy boss to the light rim in order that abrupt changes in the rate of cooling, after the pulley has been cast, may be avoided. The width of the arms at the rim is generally two-thirds that at the boss.

There is no hard and fast rule to determine when arms should be used in preference to a solid web; it depends largely on the width of the pulley, but solid webs are used for pulleys up to 12 in. in diameter. This, however, is unusual, 6 to 8 in. being about the limit. From these sizes up to about 18 in. in diameter four arms suffice instead of the web, but for large pulleys the number is invariably six. Very large pulleys that are over 7 or 8 ft. in diameter may have eight or even ten arms. With regard to the radius for curved arms no definite rule has been established, it being a matter of taste and experience, always bearing in mind the object of the curving. The unequal rate of cooling between the rim and the boss, due to the difference in the sectional thickness, causes strains upon the arms, which strains are considerably reduced when the arms are curved, as then the strain merely tends to straighten them. The danger of fracture or weakness because of internal strains is lessened by making the boss as light as is possible commensurate with strength, so that the cooling of the casting will be as regular as possible.

Sometimes when the arms are made very thin the casting is stiffened up by ribs on the centre lines of the arms, forming in section a cross, but this is very rare, clumsy, and unnecessary.

When a pulley is crowned, that is when the periphery is convex, the belt rides to the highest point; thus it is an advantage in preventing the belt slipping off, and it also allows for slight



errors in alignment. Some pulleys are required to be shrouded or flanged; these are intended to retain the belt when the side space is limited and in cases where, if the belt came off, it would jam between the pulley and some other part of the mechanism. They are also advantageous in retaining the belt when a sudden strain is applied.

As a rule, flanged pulleys are not crowned; it is, however, quite as necessary to crown flanged pulleys as plain ones, otherwise there is a tendency for the belt to mount the flanges; in any case, severe rubbing is likely to take place which reduces the efficiency of the belt.

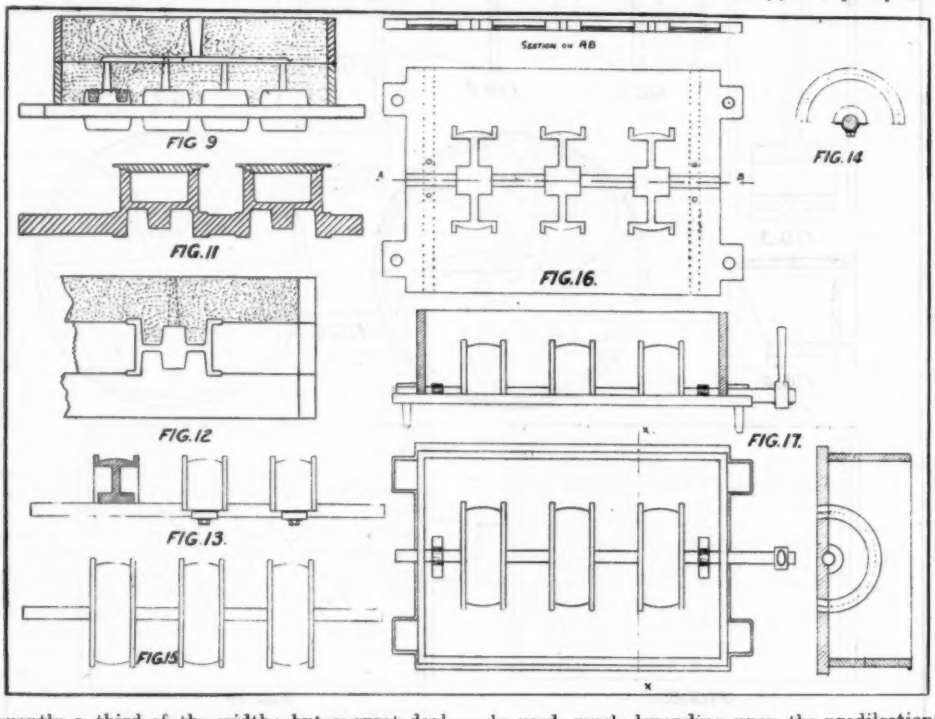
When two pulleys have to be designed to work together the ratio of diameter should not exceed 6 to 1, and the arc of contact of the smaller pulley should not be less than 165 degrees. It is an advantage to introduce an idle pulley when the ratio between the working pulley is high. In designing the arms, besides making the elliptical section a gradual taper from the boss to the rim, it is very important that the contact with the rim and boss respectively should be gradual rather than abrupt, and this involves radii to ease the shape. Sometimes the radius used for the wide part of the arm is three-quarters of its width, and that for the inside of the outer part of the arm is frequently a third of the width; but a great deal depends on the size of the pulley, and when the patternmaker designs the arms himself he may work to certain radii, but invariably he will spokeshave an arm until he considers the shape to be suitable, then make templates from which to work off the other arms. As a general rule, the width of the arms at the rim can be safely made to the following formula:—

$$\text{Width of Arm at Rim} = (0.04 \times \text{dia. of Rim}) + \tfrac{3}{4}$$

then " " " " $$\text{Boss} = \frac{(0.04 \times \text{dia. of Rim}) + \frac{3}{4}}{2} \times 3$$

The width of belt is decided by the face of the pulley, and should be from $\frac{1}{4}$ to $\frac{1}{2}$ in. wider. The rim, according to the size of the pulley, ought to be from 3-16 to 5-16 in. thick. When internal flanges are desired they are usually about half the thickness of the arms. In proportioning the boss, the size of pulley and the diameter of shaft should be considered and the method of securing the pulley to the shaft has also an important bearing on the diameter of the boss. Fast pulleys secured by keys or studs frequently have the boss twice the diameter of the shaft. Some authorities stipulate that the metal round the boss should be 7-16 of the shaft diameter. There are several formulæ for determining boss diameters, but it is safe to allow half the diameter of the shaft as the thickness of metal for small pulleys and 7-16 of shaft diameter for larger pulleys. When screwed sectional pieces are used for securing the pulley to the shaft, or when loose pulleys are required to be bushed, these proportions are equally as applicable. The length of the boss depends to some extent on the work it is required to perform. Thus, for fast and loose pulleys the boss should be slightly longer than the width of the rim, whereas for ordinary fast pulleys a boss two-thirds of the rim width is quite satisfactory.

We may now consider a few types of pulleys. Fig. 1 is the commonest type of pulley. Fig. 2 shows the same form of pulley with flange to prevent the belt slipping. Fig. 3 is not an uncommon form of large pulley, the internal flanges giving additional strength to the rim. The rim in this case is not crowned, though it is preferable that it should be. Fig. 4 is a design that is frequently used for horizontal driving, the flange preventing the belt running off, and Fig. 5 is a very strong type of pulley made in large sizes and for heavy work. The arms of this last type are not directly in line with each other. Looking on the face of the boss the top arms would be seen between the spaces of the bottom arms. There are no definite rules as to when a certain type of pulley should be used, much depending upon the predilections of the engineer in charge.



A comparison between a straight and single-curved arm pulley is shown in Fig. 6, and a section of the arms generally used in Fig. 7. Those few designs do not exhaust pulley types. Wrought-iron pulleys are now used to a considerable extent, the boss usually being of cast iron into which wrought-iron arms may be cast or the latter may be screwed and tapped into the boss, the extreme ends of these arms being shouldered and a rolled wrought-iron rim riveted to them; but it will not be necessary to discuss wrought-iron pulleys here as the ground will be covered by a consideration of the types shown. It may be pointed out that many sketches in this article show the arms straight as a matter of convenience only.

As the rims of belt pulleys are always ground or machined, it is not customary to make the patterns convex, but it may be profitably done when casting quantities and when the moulder's joint is made through the centre of the face. The pattern then delivers from the sand more freely than if the edge is square, and there is the substantial advantage that time is saved in the machine shop.

Repetition Work.

When large quantities of cast pulleys are required the moulding machine lends itself admir-

ably for the production of the moulds. Small pulley patterns are occasionally built of good timber, such as baywood, and mounted on a plate. When they are very small they may be turned from the solid wood in two symmetrical halves jointed through the central web, but if the size necessitates the use of segments and they are well jointed the result is very good. Many firms prefer wood patterns for machine moulding, but it is the more usual practice nowadays to prepare metal patterns. Many metals are used for this purpose, depending largely upon the metals cast by those who prepare the plate. Generally they are of brass or iron, though frequently white metal and aluminium are used.

The Preservation of Iron Patterns.

If an iron pattern is properly prepared it is very durable; but to eliminate labour and get the best results every part should be machined if possible, and those parts such as arms that cannot be machined ought to be filed and scraped. Precautions must be taken against rusting, however. A successful method employed in making an iron pattern practically rust-proof is to coat it with beeswax. To apply the wax successfully it is necessary to prepare the metal pattern with a smooth surface. This is best accomplished by warming the pattern and coating it with a solution of sal-ammoniac and water and allowing to stand until the whole surface is thoroughly rusted. A vigorous rubbing with a wire brush will remove the rust and a good polish can be given to the metal with a piece of coke. This provides an ideal surface for the wax, which should be applied warm with a soft brush, the pattern having been previously heated. The surface can be polished when it has cooled. While this surface will remain rust-proof for a considerable time the wax is gradually worn off during the operations in the foundry, hence it is advisable to give another coat of wax occasionally. When brass or any non-ferrous metal is used, after they are machined and filed they are ready for use without any protective coating.

Moulding Metal Patterns.

The mould for a metal pattern may be struck up or it may be prepared from a rough wooden pattern. If the latter it is unnecessary to devote much time to the finishing of the pattern. Neatness and accuracy are essential, but durability is not required. Double contraction must, of course, be allowed, and double machining on the ribs and boss faces.

Three Part Box Method of Castings.

Many metal patterns may be attached to one plate according to their size, and Fig. 8 shows a method of dealing with them in large quantities. When pulleys are prepared on a pattern-plate in this manner they are invariably supplied with metal from one large gate, the pulleys being connected by sprues. This method is frequently responsible for many waster castings as the sprues must necessarily be light to prevent drawing, and incidentally to reduce the time of fettling, consequently many do not run. A better way, and one which is much more economical is to prepare the moulds and runners in a three-part box, the impressions of the pulleys being carried in the drag and middle parts and a cope box carrying the impressions of suitable runners. The method is indicated more clearly in Fig. 9, which represents a section of the middle and cope parts on the pattern plate. The connections between the runners and the moulds are tapered in the reverse direction for stripping purposes, and they have the advantage of feeding the comparatively heavy bosses. The separate plate carrying the runners and gate is shown in Fig. 10. The little additional time involved in preparing the runners in a separate box-part is more than compensated by the reduction of wasters due to bad gating and the low cost of fettling. This method can be used with advantage in the production of other small castings besides pulleys. It is of course essential that the various parts should be located very accurately on the plates, so that impressions taken from them will have their true relative positions when brought together. It is convenient when possible to arrange the parts on the plates so that the impressions from them cannot be assembled wrongly.

When the flanged pulleys are desired in quantities a similar principle can be adopted if the castings are small. It is then necessary to use an additional box-part, and, as a rule, the convexity of the rim is left to the machinist to reduce the time taken in the foundry.

Pattern Plates.

Special pattern plates are equally as essential, and many methods are employed in their preparation. In some instances they consist of a special composition cast in steel frame, but, generally, some metal is employed for the purpose. While it is preferable to prepare the metal patterns separately, and secure them to the pattern plate, because they can be more accurately prepared, many plates are cast with the pattern sections on, others being cast in the form of match plates. This latter type is indicated by Fig. 11, which illustrates one form of plate used for flanged pulleys. Two impressions are taken from one side of the plate for drag and cope respectively, and one from the other side for the middle part, and assembled as in Fig. 12. When there is a variation in the width of the flanged pulleys of the same diameter, loose cylindrical metal patterns are prepared in such a way that they can be mounted on the same pattern plate; as a rule, spigot and socket joint is used for locating the patterns in the same manner as is used for locating the top flange. The width of pulley determines the length of cylindrical pattern and also the shape at one end to form the cope and drag impressions. The diameters of the bosses cast on the pulleys are frequently varied to accommodate different sizes of shafting, and where there is a likelihood of such variation it is worth while to make the boss on the pattern plate detachable, in order to facilitate any alteration desirable. When those pulleys are small the same method of pouring may be profitably employed, as has been described in connection with the unflanged pulleys, but when only one or two are carried on a plate quite satisfactory results are obtained by pouring each separately, using a bush with a prepared skimming basin over each gate.

Hand-moulding Pulleys in Quantities.

When many small flanged pulleys of a definite size are required, and it is either impossible or inconvenient to make use of a machine for producing the moulds, moderately quick production with good results can be effected by preparing half metal-patterns and securing them to a spindle, as shown in Figs. 13, 14, and 15. Brass patterns are usually employed, and they are machined all over, the joint surfaces being machined and sweated together in pairs for the purpose. As a rule, two or four half-patterns are attached to the spindle, and when it is desired to cast a hole through the boss, it is convenient to make the diameter of the spindle correspond to that of the hole. A special stripping plate is prepared, as indicated in Fig. 16, to which bearings, which hold the spindle, are secured. The making of the stripping plate requires considerable care to be satisfactory. Sometimes a cast-iron plate is used having a semi-circular recess cut away from its centre to enable the centre of the spindle to coincide with the working surface of the plate. The holes in the plate through which the patterns are to pass, when stripping, should be filed out accurately to shape. It is best to mount the spindle with the pattern attached in the desired position relative to the pins and scribe the shape of the holes and their position on the plate, then to follow these lines accurately when filing. When the plate is completed and the spindle finally set, a short handle is secured at one end of the spindle, usually vertical to or horizontal with the surface of the stripping plate. The plate is then ready for use in the manner indicated by Fig. 17. Generally, a number of drag impressions are first made, a cope box part being used as a support and for locating the relative position of the two parts. Hand-ramming is resorted to, and the patterns stripped by giving the spindle half a turn, causing the pattern to reverse their positions and pass through the stripping plate. Apart from the advantage derived from the reduction of joints in the moulds, this method also gives the convexity on the rim desirable in this type of pulley.

(To be continued.)

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Electric Furnaces in the Foundry.*

By D. Wilkinson.

Since the inception of the electric furnace industry rapid progress has been made, and to-day there are over 1,000 electric furnaces of various designs used in the metal industries of the world. They are used in the manufacture of every variety of tool, alloy and constructional steel, for steel castings, for high-grade cast-iron, and for melting brass, bronze and non-ferrous metals generally.

In discussing the subject of electric furnaces the writer has considered it better to omit any detailed description of the construction of various furnaces. Views and diagrams are common in the technical papers.

Nature of Current Used.

In the early days of the electric steel furnace there was keen rivalry between the arc and induction type of furnace. There was little or nothing to choose between the quality of the product from either furnace, but the comparative structural simplicity of the arc furnace gave it so much advantage in first cost and in maintenance, and also in operation, that the great majority of furnaces in use to-day are of the arc, or modified arc, type. In discussing furnace construction the question is sometimes asked why alternating current is exclusively used. One very convincing reason is that it is cheaper to generate. But in addition to its extra cost, there is another reason why direct current is not used, although this second reason is perhaps more a theoretical than a practical one. Direct current passing through a compound liquid bath of any description always exerts an electrolytic effect. A familiar example is the ordinary electroplating operation, where, on passing the current, metal is dissolved at one pole and deposited on articles suspended from and in electrical contact with the other pole. Another example is the abovementioned furnace, in which aluminium is manufactured. This furnace is, in effect, a carbon trough, in which is melted alkaline aluminium double fluorides. In the molten material is dissolved prepared alumina. Direct current is passed through the bath, and the net result, omitting all intermediate chemical reactions, is that aluminium is liberated at one pole, and carbon monoxide gas at the other. If, in either of the above examples, alternating current were to be substituted, all action would cease. The current, reversing or alternating its direction of flow anywhere from 20 to 50 or 60 times per second, each alternation would exactly reverse the work of the previous one, and so no electrolytic action would be possible.

The theoretical objection to the use of direct current in an electric steel furnace is that there might be a tendency for metalloids to accumulate at one pole, and this accumulation would reduce the speed of refining, and would also make the finished steel less homogeneous. Whether or not this would actually occur in practice the writer cannot say, but certainly the possibility is there. In any case, to the best of the writer's knowledge, alternating current is invariably used in commercial electric furnace work, direct-current being used only in a few experimental furnaces.

The Efficiency of the Electric Furnace.

There are several arc furnaces on the market capable of producing excellent steel. They vary a little in shape, in the arrangement and number of electrodes used, in the way they are connected to the transformers and in the character of the lining, but their differences are in minor structural details rather than in principle. Each type possesses what are claimed to be well-marked advantages over other types, but local conditions under which current can be obtained will frequently be the deciding factor in settling the most suitable furnace. Very low current consumption per ton of steel is frequently claimed for new designs, but usually low current consumption depends far more upon careful operation than upon furnace construction. The man who is tempted by very low figures may find his ideal elusive. On the point of current consumption some furnace salesmen are incurably optimistic. Figures obtained by the writer over a series of 1,100 runs show an energy consumption of 797 kw.-hrs. per ton of steel in the ladle. The furnace was worked with one slag only, and the steel was required very hot. Another set of figures from a furnace of a different type working with two slags showed a current consumption of just over 900 kw.-hrs. per ton of steel in the ladle. In each case the figures were obtained by dividing the total consumption, as shown by the furnace kw. meters, by the total weight of steel in the ladle. Figures are sometimes published showing an energy consumption, melting cold charges, as low as 550 kw.-hrs. per ton of steel. An overhaul of the kw. meters should be recommended in these cases.

It is not a difficult matter to obtain a rough idea of the minimum current consumption per ton of steel. Taking the ordinary calory and omitting all calculation, we may say that in one ton of steel at a temperature suitable for castings there will be at least 375,000 calories. The slag will contain 600,000 calories per ton. As the total weight of slag, when working with two slags, will be approximately 18 per cent. of the weight of the steel, we have another 108,000 calories. Taking the heat equivalent of the kw.-hr. at 865 calories gives 483,000 ÷ 865 = 558 kws. required to furnish the heat contained in one ton of steel ready for pouring. A certain amount of heat is generated, and some is absorbed, by chemical action within the furnace, but very much more than is generated by refining reactions will be lost through unavoidable causes. These are:—(1) Electrode losses; (2) radiation losses; (3) cooling water losses; (4) losses during skimming; (5) losses during charging and fettling; (6) variable losses while the furnace is standing and when it is relined.

All these items have to be paid for, so should appear as current consumed in figures giving this information. Heavy heat losses obviously occur during the skimming of the first slag, and during fettling and charging the furnace. The losses in the electrodes will sometimes amount to as much as 10 per cent. of the current used. Economical operation is more likely to result from attention to these details than from minor variations in furnace design. When working with one slag only, the heat losses from skimming will be cut out and the reduced weight of slag will require less current, but when all is considered, it is safe to say some of the figures occasionally published do not represent the amount of electricity required, over a period, to produce one ton of steel with the sulphur and phosphorus reduced to a minimum.

The Chemistry of the Process.

The lining of the furnace may be acid or basic. The acid lining is made with silicious refractories, and is used where the materials to be melted are considered sufficiently pure to require no refining. With careful working a slight reduction of sulphur and phosphorus may be obtained, but the reduction is not great, and is difficult to obtain regularly. Generally speaking, however, the primary object in using an electric furnace for steel melting is to reduce these elements to their lowest amounts, and in this case a basic lining is essential.

Phosphorus and sulphur can only be removed from a molten bath of steel by a slag containing a high percentage of lime. Such a slag cannot be used on an acid or silicious lining. Exactly as the limestone in the cupola fluxes the silica, or sand, on the iron, so the lime in the slag would flux the silica in the furnace lining, and the result would be its rapid and complete destruction. To avoid the fluxing action of the lime, a basic lining is used. Generally this is made of calcined dolomite. Upon this material the lime in the slag has no chemical action.

The charge, within reason, may be composed of practically any sort of steel scrap, but as a lengthened refining period means a reduced output and an increased current consumption per ton, it is usually found better to select a good quality

* A paper read before the Birmingham Branch of the Institution of British Foundrymen on November 12.

of scrap. It is less costly to use good scrap than, with an inferior scrap, to use more current and obtain less steel per day. The slag-forming materials, lime, sand, iron ore and a little fluor-spar, should be charged into the furnace with the scrap. Using a good scrap of a fairly regular composition, the writer has found it best to charge, say, 10 per cent. of the scrap, then add the slag forming materials, followed by the remainder of the scrap. By carefully proportioning the lime and ore and mixing them with the charge, the phosphorus and carbon will both be reduced to the required percentage by the time the metal is melted and sufficiently hot enough to skim. With good scrap containing carbon 0.4 per cent., and phosphorus 0.06 per cent., the phosphorus will be reduced to about 0.005 per cent., and the carbon to under 0.1 per cent. In the presence of a sufficient amount of lime the phosphorus in an oxidised bath forms phosphate of lime, which is a stable constituent of an oxidised basic slag. The carbon is oxidised to carbon monoxide, which escapes and burns. The removal of the phosphorus is the result of reactions, at a low temperature, between ferrous phosphide, oxides of iron and lime. Stead, Ridsdale and others have shown that phosphorus exists in a basic slag as an oxide in combination with four atoms of lime. The following equations express the reactions:—

I. $2Fe_3P+5Fe_2O_3=3FeO.\ P_2O_5+11Fe+2FeO.$
II. $2Fe_3P+8FeO=3FeO.\ P_2O_5+11Fe.$

Probably both of these reactions go on together during the oxidation of the bath. The combination of the ferrous phosphate with the lime is expressed by the equation:—

$$3FeO.\ P_2O_5+4CaO=4CaO,\ P_2O_5+3FeO.$$

The result of the above reactions is the formation of tetra basic phosphate of lime, which, as noted above, is a stable constituent of an oxidised basic slag. The oxidation of the carbon is according to the reactions:—

I. $3Fe_3C+Fe_2O_3=3CO+11Fe.$
II. $Fe_3C+FeO=CO+4Fe.$

Both of these reactions go on together. Usually, during the melting down, about 15 to 20 per cent. of the sulphur is eliminated, but this does not always occur. The bath should be skimmed immediately it is hot enough to stand the heat losses due to this operation. The skimming should be thorough, as any slag left behind will return its phosphorus to the steel during the deoxidising period. It may be of interest to note the writer has found the bath sample invariably lower in phosphorus than the finished steel, no matter how carefully the skimming was carried out. This is due to the lining holding a thin coating of slag at the slag line and on the portion of the back lining exposed when the furnace is tilted for skimming. During the reducing period of the run the phosphorus is reduced from this slag and returned to the steel. While the steel is free from slag it will be found of advantage to add a little ferro-silicon to deoxidise it and so speed up the operation of the second slag.

The second, or reducing, slag is now added. It consists of lime, sand and a little fluor-spar. With the heat of the arcs above and the steel below these materials speedily combine and melt. When they are melted, and the surface is completely covered by the newly-formed slag, a mixture of ferro-silicon and carbon is sprinkled over it. The carbon should be as free as possible from sulphur. The material usually used is a form of retort carbon obtained during the distillation of oil, and known as oil cake. Its first action is to complete the deoxidation of the steel. It is to shorten this period the ferro-silicon is added after skimming. When deoxidation is complete the sulphur removal commences. Under the intense heat of the arc the lime and carbon form calcium carbide, and this reacts with the ferrous sulphide of the steel forming calcium sulphide, which is a stable constituent of a non-oxidising or reducing slag.

$$3FeS+CaC_2+2CaO=3Fe+3CaS+2CO$$

At this stage, a sample of slag taken out of the furnace and quenched in water will disintegrate to a white powder, and will give off a distinctive odour of acetylene gas. It is important to maintain reducing conditions in the furnace, as if any oxidation takes place sulphur is returned to the steel. Calcium sulphide readily oxidises to sulphate, and in this form it reacts with the iron forming lime, sulphide of iron and oxide of iron, both of which latter are taken up by the steel.

$$CaS+2O_2=CaSO_4.$$
$$CaSO_4+4Fe=FeS+3FeO+CaO.$$

Sulphur is also removed by the ferrosilicon. The reaction is somewhat involved and rather technical, but the ultimate result may be written as:—

$$2\ CaO + 2\ FeS + Si = 2\ CaS + SiO_2 + 2\ Fe.$$

Either carbon or ferro-silicon alone will effectively desulphurise the steel, but the writer has found this operation to be under better control when they are used together. It may be noted that desulphurisation cannot be carried out until the slag and bath have been thoroughly deoxidised. If oxide remains in the slag the stable formation of calcium sulphide would be prevented by the following reaction:—

$$FeO + CaS = FeS + CaO.$$

The resulting ferrous sulphide would be returned to the bath.

When the steel has acquired the casting temperature and the slag is white the finishing alloys should be added and the steel cast. The weight of ferro-alloys added will, of course, depend upon the percentages of silicon, manganese, etc., required in the steel. With a well-finished heat the proportion lost is not serious. It may be noted here that deoxidation can be carried out so thoroughly in the electric furnace that it is possible, before the ferro-alloys are added, to take a spoon sample and cast a test ingot which shall be sound and perfectly free from any trace of blowholes. The writer has done this with a metal containing 99.8 per cent. iron.

The physical characteristics of electric steel, as compared with ordinary steel, are greater homogeneity and freedom from segregation, a higher elastic limit and yield point, and a more marked resistance to fatigue both in use and on the testing machine. This last characteristic is also indicated by an increased contraction of area in the tensile test. All these characteristics might be expected to result from the removal of phosphides and sulphides, with their usual hardening and embrittling effects. Any required tensile strength may easily be obtained by varying the carbon content of the steel.

Non-Ferrous Electric Furnaces.

The electric melting of non-ferrous metals has lately come to the front, especially in America. Obviously, the type of furnace suitable for melting steel would not be suitable for melting brass, bronzes carrying lead, aluminium and other metals and alloys easily vaporised or overheated. Some bronzes, and the nickel alloys, may be successfully melted in furnaces of the steel type; but, generally speaking, non-ferrous metals are not successfully melted by allowing the arc to strike the charge. The intense heat of the arc, between 3,500 deg. C. and 3,800 deg. C., will readily vaporise even copper; and losses by volatilisation are heavy. As zinc boils at 930 deg. C. and lead at 1,580 deg. C., it is evident these must be kept from contact with the arc when melted. Copper is volatile at 2,310 deg. C., so there is a greater margin here: but even this metal will readily vaporise when the arc plays on it after melting. Basically, it is a question of the ratio between the heating effect of the arc and the conducting power of the metal. When the energy input is higher than the rate of heat conduction through the metal, the temperature under the arc rises rapidly, and volatilisation occurs. If the heat can be poured before the metal under the arc reaches its boiling point, losses will be small; but alloys containing zinc, lead, antimony and other metals of low boiling points will suffer heavily.

Indirect arc heating is successfully used in several furnaces. One type consists of a cylindrical shell, with small doors located on the axis at each end. The electrodes enter through these doors. At one end is a tapping hole, and, with the exception of this hole and the doors, the walls of the cylinder are unbroken. This enables the furnace to be rotated upon its axis, and during melting this rotation takes place. The arc is struck between the ends of the two electrodes, and the

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rotation of the furnace, by rolling the charge over, continuously exposes fresh surfaces to the heating action of the arc and the heated lining. This results in a very even temperature gradient during the melting and in the maximum heat transfer to the metal. The melting loss in this furnace is said to be under 2 per cent., even when melting turnings and borings.

Another successful type has a trough, made of carborundum, crossing the furnace above the hearth. This trough is filled with carbonaceous material, and the electrodes enter it from each end. The resistance of the material in the trough to the passage of the current generates heat which is radiated on to the charge beneath, directly from the resistor trough and indirectly from the roof and walls. As there is no arc in this furnace, the risk of losses by volatilisation is considerably reduced.

Several other interesting types are on the market. Obviously, with the cutting out of crucible costs, the greater cleanliness of the furnace operation, the reduced metal losses (granting these are achieved), and the high thermal efficiency which can be obtained as compared with ordinary crucible furnaces, there should be an extensive field for the electric furnace in the non-ferrous foundry.

The Electric Furnace in the Iron Foundry.

At the present time attention is being directed towards the electric furnace as an iron foundry appliance. From the earliest days of electric furnace development pig-iron has been reduced from the ore by various types of furnaces; but the use of the electric furnace either to replace the cupola or as an adjunct to it, has only recently been seriously considered, but the time has not yet come for the cupola to be ousted from its present position. It is quite conceivable, however, that for certain purposes the increased cost of electrically-treated cast iron might be compensated for by its improved quality, always granting that the improved quality exists in the casting and not in the imagination. It is easily possible to obtain as poor an iron from an electric furnace as from the cupola. When properly handled, the resulting improvement is so marked that for certain classes of work the increased cost should not be prohibitive. But for general castings the increased selling price would quite prevent sales, and no good purpose can be served by improving a material in a manner that puts it out of the market.

The replacement of the cupola by the electric furnace may be considered along the lines of what is now known as the manufacture of synthetic cast iron.

In 1915, when the shortage of hematite was very acute, the writer, in a search for supplies of this material, went over a small works where synthetic cast iron was being made in an ordinary electric furnace. Various grades, from white to all grey, were being produced. The fractured surfaces were all very finely grained, and the tensile strength of the grey iron was said to be 20 tons per square inch. The venture, despite the abnormal demand for hematite, was not a financial success, doubtless owing to the size and unsuitable design of the furnace.

The production of synthetic cast iron was developed on a large scale in France during the war for the manufacture of cast-iron shells. A description of the process was given in a Paper read before the Iron and Steel Institute at the September meeting, 1919, by C. A. Keller. This gentleman was among the earliest patentees of processes for making cast iron direct from the ore by electrical methods. The synthetic iron process is simple in principle. Steel turnings, mixed with carbon in the shape of small coke or charcoal and a proportion of lime and sand, is charged into an electric furnace. As the charge heats up the carbon combines with the steel, reducing its melting point considerably. The lime and sand serve a double purpose. They reduce the high conductivity of the charge, and so enable an ordinary voltage to be used in the furnace. The lime, under the strongly reducing conditions resulting from the amount of carbon present, combines with the sulphur in the steel and carries it into the slag. The silica of the sand is reduced to silicon by reaction with iron and carbon, and results in the production of grey cast iron. The process can be closely controlled, and yields a really excellent cast iron. As much as 300 tons per day of this material is said to have been made by this method at Livet, France, where there is a very large installation for the generation of electricity by water power. The current consumption is stated to have been as low as 675 kw.-hours per ton.

According to figures given in the Paper a remarkably strong iron was obtained. The following composition is given:—Carbon, 2.90 per cent.; silicon, 1.75 per cent.; manganese, 0.50 per cent.; sulphur, traces; phosphorus, 0.05 per cent. From this iron a tensile strength of 50 kilos. per sq. mm. is said to have been obtained. The remarkable strength will be recognised when it is calculated into British terms. The resulting figure is 31.74 tons per sq. in. It certainly seems an almost incredible tensile strength for a cast iron of any description or composition. While the writer has obtained some excellent tensile results with electrically-treated cast iron, this figure goes far beyond the best he has ever seen.

Synthetic cast iron can be made in any ordinary electric steel furnace, and during the period of the war the writer assisted in carrying out trial runs which, so far as product was concerned, were very satisfactory, but the cost was too high. In these trial runs, the turnings contained carbon 0.42, silicon 0.21, manganese 0.79, sulphur 0.066. and phosphorus 0.058 per cent., and the coke, carbon 88.40, volatile matter 1.36, sulphur 0.93, and ash 9.21 per cent.

It is necessary to use turnings and to mix thoroughly the ground coke with them in order to economise energy. Ordinary foundry or forge scrap does not expose sufficient surface to the carburising action of the coke mixed with it to complete carburisation before melting. If the charge melts before carburisation is complete, it can only be completed by solution of the carbon in the molten metal, and the solution becomes slower and more difficult the higher the percentage of carbon rises. To introduce about 3 per cent. of carbon into the resulting cast iron, 5 per cent. of ground coke is necessary; 5 per cent. of lime and a little sand is added to form a desulphurising slag. This mixture is charged on the preheated hearth of an electric furnace and the current switched on. Carburisation begins at a dull red heat, and becomes more rapid as the temperature rises. As the charge becomes semi-molten, the action is very energetic, and by the time fusion is complete, in the neighbourhood of 3 per cent. of carbon, will usually have been absorbed by the metal. By the action of the lime, the sulphur will be considerably reduced, and the resulting metal will be a good quality white iron. In operation it was found more economical to add the silicon by means of ferro-silicon rather than by the reduction of silica in the furnace. When, after adding the ferro-silicon and rabbling, a test sample showed a grey homogeneous fracture, the metal was poured out and cast.

The composition of the product showed the sulphur was reduced considerably; the phosphorus was not altered, and the manganese lost usually about 10 per cent. of its content. To replace this loss a few pounds of 80 per cent. ferro-manganese were added to the ladle. The analysis of one heat was:—Combined carbon 0.47, graphitic carbon 2.16, silicon 2.28, manganese 0.84, sulphur 0.022, and phosphorus 0.060 per cent.

The Physical Properties of Synthetic Iron.

Tensile tests taken on material of this analysis gave the following results: (1) 21.5, (2) 19.9, (3) 21.2, and (4) 21.0 tons per sq. in.

Transverse tests taken on a bar 2 in. × 1 in., with 3 ft. centres, gave 39.2 cwts. with 7/16 in. deflection, and 39.4 cwts. with 7/16 in. deflection. The specific gravity was 7.53. As the average specific density of grey cast iron is about 7.2, the higher specific gravity of synthetic cast iron shows it to be of a considerably increased density. The conditions under which it is made ensure its perfect deoxidation; and its freedom from other dissolved, occluded or combined gases will be rendered certain by the temperature to which it is raised, and the strongly reducing slag covering it while in the furnace. Microsections showed

the graphite in an extremely fine state of division and uniformly distributed in a matrix of pearlite and silico-ferrite.

The metal is intensely hot and very fluid. Moulds cast with it had to be prepared with great care if smooth castings were to be obtained. When poured into the moulds it remained fluid for a considerably longer period than cupola metal; and its feeding qualities were obvious when the sinking down of the runners and risers was observed. The castings were close grained and sound, and the high specific gravity resulting from the close grain marks it as being suitable for light castings to resist internal pressure. Its fluidity was such that the runners were reduced in number and in size without the slightest tendency towards cold shuts or mis-runs. Dry-sand moulds had to be closed with great care and cottered very tightly to prevent runouts, and if a runout did occur it was very difficult to stop it.

The Duplex Process.

The use of the electric furnace as an adjunct to the cupola will effect a considerable saving in current consumption, and the quality of the resulting metal can be brought up to the figures obtained from synthetic cast iron. If the electric furnace is to be developed in the cast-iron industry, it will be essential to obtain the utmost economy, as when everything has been done to cut down the cost to the minimum the metal will still be expensive. The purchase and maintenance of an electric furnace and the high price of electric current add a serious item to the costs of grey-iron castings. Melting in the cupola is certainly cheaper than melting in the electric furnace, and in the interests of economy this should be done. As regards the composition of the metal thus treated when compared with synthetic cast iron, the use of hematite would give an equally low phosphorus; but, in the writer's opinion, a moderate amount of phosphorus would not be objectionable. In fact, he is inclined to believe that phosphorus up to 0.3 or 0.4 per cent. would be an improvement, as it would increase the rigidity of the metal and yet not be sufficient to induce brittleness. This percentage could readily be obtained by the use of a medium phosphorus pig and steel scrap.

The writer's experience leads him to think a basic lining in an electric furnace is not at all suitable for iron foundry requirements. The furnace itself could be so modified that it would be much cheaper to erect and maintain, and more convenient for use with cast iron than any that has as yet come under his notice. Few foundries require molten iron more than three or four hours daily. The foundries requiring molten iron continuously, that is, for 20 to 24 hours per day, are so few that they do not enter into the general question. This intermittent demand for metal is a source of serious trouble and expense with a basic lined furnace. Unless a basic lining is kept constantly hot, it rapidly disintegrates and is destroyed. At the temperature required for cast iron, a basic hearth in continual use would last at least several months; but if it were allowed to cool off each night it would not last many days, owing to the severe strains set up by alternate expansion and contraction, cracking the lining and making it spall off when re-heated.

The writer would suggest, instead of a basic hearth, a neutral one made of carbon. This would not be possible in steel melting, as the steel would attack and destroy it; but cast iron already heavily charged with carbon, would have no action on it. The calcareous slag required would also, if properly proportioned, be without chemical action upon it. The furnace itself should be built up after the manner of an air furnace; well braced with buck-staves and side plates. There is no need for an electric furnace handling cast iron to be tilted. A furnace, solidly built, with walls and roofs of the highest quality firebrick, having a hearth about 5 ft. × 2 ft. 6 ins., with well-tapered sides about 1 ft. 8 ins. deep, would hold three tons of cast iron, and the slag required to refine it. The electrode holders could be either attached to the walls or built up separately. At one end a tapping hole and spout should be located, and at the other end a charging spout should be fixed. This spout should be sloped gently upward from the top level of the hearth, and should be closed where it enters the furnace by a small door. The roof should, preferably, be movable to facilitate repairs. A door on the side opposite the electrodes would allow the refining to be controlled, and would also enable the slag to receive all the handling it would need. The hearth should be made of ground coke mixed with hot pitch and tar in suitable proportions and solidly rammed into place. Two electrodes only would be required, with Scott connections to three-phase current at the transformers (Electro-metals system). Such a furnace would, with care, last as long as an air furnace, and would be considerably cheaper to build than an ordinary electric furnace. Also, it would not come to any harm however frequently it was cooled down. A furnace on these lines could easily handle 20 tons of cast iron during an afternoon. The writer has not heard of a furnace of this description in operation; but if there is one he would be very glad to receive particulars of its working, as he is of the opinion it would be economical in upkeep and in current consumption.

A proposed process of such a furnace in an ironfoundry would be as follows:—About two hours before the cupola would be put on blast, the furnace, cleaned and patched after the previous day's run, would be charged with about one ton of small scrap from the last heat. A liberal amount of ground coke would be spread over the iron. Current would be applied slowly at low power initially, gradually increasing as the furnace warms up. After from 1½ to 1¾ hours, the scrap would be melted and covered with the ground coke, and the furnace would be fairly hot. The lime, sand and fluor-spar to form the slag would then be charged, and by the time the cupola was delivering metal the slag would be melted, the furnace would be hot, and the iron already in it would be in good condition. From the cupola two tons of metal would be tapped and poured down the charging spout into the furnace, mixing with the iron and slag already there. The full current, from 700 to 800 kilowatts, would be switched on, and refining would begin. The first heat would probably require about half an hour's run. Experience would soon show the correct time to start the furnace so that by the time the first heat was refined the furnace would be at the full temperature. Two tons would be tapped out, and another two tons brought from the cupola and poured into the remainder of the charge left in the now highly-heated furnace. Deoxidation and desulphurisation would be rapid under the action of the hot active slag. At intervals, as the slag became spent, it would be partially raked off and new slag-forming materials added. By adding carbon, fluor-spar and lime as required, a strongly reducing slag could readily be maintained. By working in this manner, taking out only two tons per tap, leaving the remaining ton to mix with the fresh cupola metal, it would be possible to make a tapping every fifteen minutes, taking off two tons of thoroughly deoxidised, desulphurised and superheated metal. The metal, as drawn off, would be at such a temperature that, if covered with blacking, it could be kept until the next tap was made, and still be sufficiently hot to satisfy the most exacting demand for hot iron. With good cupola practice and treatment under these conditions, metal of faultless composition and properties could be relied on.

In conclusion it may briefly be noted that iron for malleable castings treated in this manner would be certain to give a tensile strength and an elongation after annealing that would be a revelation to founders accustomed to the present quality of castings. Within a very few years one may venture to state great developments along these lines will occur, with advantage both to founder and consumer.

MR. D. B. MORISON, chairman of Richardson, Westgarth & Company, Limited, addressing a gathering of employés at the Hartlepool Engine Works, announced that the company had arranged to commence the manufacture of Diesel engines of both marine and land types, and hoped to make a start on the building of these engines in the course of the next few weeks, or at all events early next year. They had decided to adopt the well-known "Tosi" engine, and had already received orders from Furness, Withy & Company, Limited, for engines of this type for two ships, the value of the order being about £230,000.

XUM

Endurance Testing Machines.

By G. SHAPIRA.

It has been long observed that the action of notching as also the phenomenon of fatigue particularly incurred by impact stresses. have a most detrimental effect on the security of constructional parts, especially if such parts are made of steel or iron. In order to ascertain the numeric value of such phenomena, numerous tests have been applied, imitating as closely as possible the stresses put on the material under working conditions. Both the industry and technical institutions engaged in testing constructional material experience the need of measurable and comparable numeric value by simple tests. Such figures would convey a true picture of the different effects which repeated impact stresses have on the various materials. It is in cases where the highest grade materials have to be employed that the three dangerous factors work together, viz., the effect of notching, the impact stress, and constantly repeated stresses. For example, crankshafts and axles. It is true the notching tenacity test has

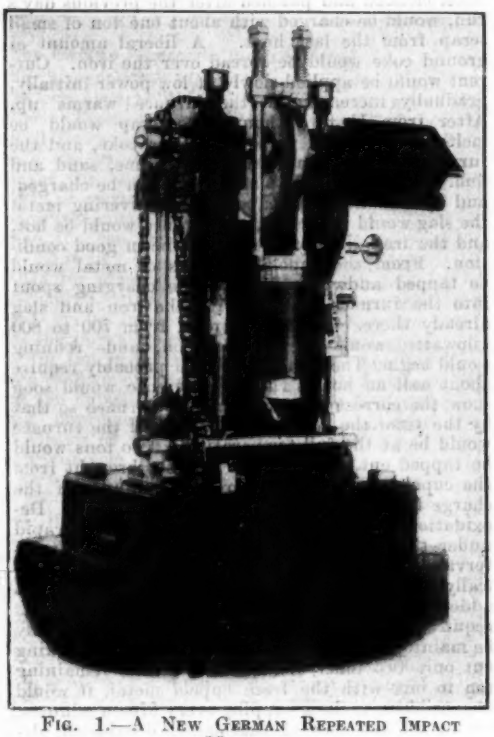


FIG. 1.—A NEW GERMAN REPEATED IMPACT MACHINE.

been standardised for many years by the use of the standard pendulum shock machines. Moreover, the notch shock test has found a wide field. Considering, however, that the test-piece is destroyed by a single blow, it is impossible to ascertain the strength of the tested material at repeated stresses. Now such repeated stresses, especially if the direction of the stresses varies, may easily lead to a rupture.

A New German Machine.

The Krupp repeated impact machine (shown in Fig. 1) has been constructed with a view to clearing up these circumstances. In this machine turned test-pieces of specified dimensions, which on both ends rest on supports, are submitted at their centre to a shock bending test by means of a ram, the shocked part of the test-piece being notched. A catch contrivance turns the test-bar after each shock by a certain angle. Sooner or later, according to its strength, the piece breaks, a counter marking the number of shocks necessary for the bringing about of the rupture. The tests have shown that steels differ greatly with regard to the number of shocks required for their breaking.

In the test machine a ram of constant weight is raised by means of a cam-shaft at each turn and then is allowed to drop down on the piece to be tested. The shaft is driven by a small electric motor by means of a worm gear. The ram is suspended from two holding rods, which themselves are elastically connected to the pulley transverse piece, the lifting cam working on the pulley itself. The framework containing the bearings for the cam-shaft as well as for the test piece, also embraces a perpendicular guide, along which the ram is moved up and down, while its lower, hardened head strikes the middle part of the test-piece. The latter is supported in two places, and secured against any shifting aside and any jumping, its notch being just below the middle of the ram. After each shock the test-piece is turned by means of a gear in such a way that it is only moved during the time the ram is moving to and fro, while it is kept still during the time of its being struck by the ram. The distance to be covered by the test-piece can be adjusted either with a half turn, if an intermittent shock test is desired (Fig. 1), or with a quarter turn if a continuous shock test is necessary. In this manner it is possible to imitate the strains to which crankshafts or axles are exposed.

The counter is put in motion by means of the cam-shaft. The number of shocks required for the rupture is automatically registered by the ram dropping down lower, through which a circuit breaker is released, thus bringing the motor to a standstill. The whole machine is mounted on a cast-iron box, which in its interior contains the motor.

The work of every shock amounts to about 12.5 centimetre kilogrammes and the number of shocks to 85 per minute. Although the number of shocks a minute practically influences the result of the test to a very small extent only, it is advisable to see that this normal number of shocks be adjusted. The normal test-piece is a cylindrically-shaped bar of 15 mm. diameter, with a notch of 13 mm. in diameter. At its left hand end the bar is provided with a guide for the catch-pin of the turning gear; whilst at the right a nut is turned in to secure the piece from shifting sideways. In view of the fact that the number of shocks necessary to break the bar varies between 2,000 and 100,000 for test-pieces which are turned 180 deg., the duration of the whole tests accordingly varies between half an hour and 20 hours respectively. In the second case, with a quarter turn, the number of shocks is approximately double.

In all cases where a certain notch tenacity is required, the repeated-impact machine, together with the pendulum shock machine, constitute the best means for testing the strength of material. In order to realise the meaning of such tests, the word notch must be interpreted in its widest acceptation, as it is generally employed. Of late, every bore-hole transverse to the direction of the working force, every nick, each sharp bend in the outline of a constructional part conjure up the danger of notching effects. However, it deserves mention that in this respect materials of the same strength turn out to be very different, and are more or less liable to ruptures.

Certainly the number of shocks does not procure the correct measure of the notching tenacity of the tested material, but the final results depend also on the upper yield point of the material employed. Materials of the same susceptibility to notching will require a higher number of blows the higher their yield point is.

The Amsler Machine.

The Amsler wear and tear testing machine, shown in Fig. 2, is designed for ascertaining the destruction of metals by friction. Between the metals to be tested, either rolling friction or sliding friction alone, or both rolling and sliding, friction occurs as desired. The pressure on which the metals bear on each other can be varied within a wide scope. Furthermore, a shocking stress can be produced temporarily or periodically. Such stresses as exist between a rail and a locomotive wheel can be reproduced artificially.

The metals to be tested are machined to the form of a round disc of from 30 to 50 mm. diameter and 10 mm. of thickness, and are run on each other's circumference under a definite pressure and in the opposite direction. The proportions of the diameters of the discs can be chosen so that either only rolling or sliding or partly rolling and partly

sliding friction takes place. If the upper disc is fixed rigidly there is only sliding friction. The discs make 200 turns per min.

The support of the upper disc is pressed down by a spring, the tension of which can be varied at will. The pressure on the test disc is marked on a dial and amounts to a maximum of 300 kg. While the shaft on which the upper test disc is mounted is set in motion, the support of the shaft is constantly moved to and fro by means of an eccentric to prevent the test discs from corroding. This movement also takes place when the upper disc is stationary.

A second eccentric is provided with a view to separating the two discs for a brief instant at each turn. The shaft bearing the lower disc turns continuously. It is actuated by an electric motor, and the number of revolutions is indicated by a counter. Between the shaft and the motor a dynamometer is inserted, indicating the momentary resistance of the two discs. Additionally, there is an integrating indicator denoting by means of a counter the mechanical work consumed by the friction of the discs. The dynamometer consists of a pendulum, which, owing to the forces operating, is swung out of its perpendicular position, the amount of which is a measure of the

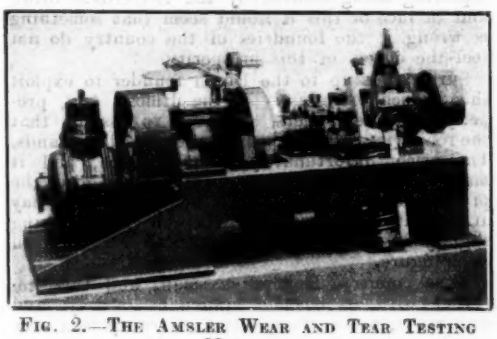


FIG. 2.—THE AMSLER WEAR AND TEAR TESTING MACHINE.

force. The contrivance for measuring the work consumed is made up of a horizontal disc rotating in proportion to the number of turns of the motor shaft, and on which an integrating pulley is moved radially by the pendulum. The integrating pulley bears a counter, from which can be seen the mechanic work absorbed. By loading the pendulum with suitable weights the scope of the dynamometer and of the work meter can be altered and adapted to the varying strengths of the piece to be tested. The machine is driven by an electric motor. Once in operation it can be allowed to run freely without supervision.

All rotating parts are mounted in ball-bearings. The wear and tear of the test disc can be ascertained either by weighing it before and after the test, or by measuring its circumference. The latter method is effected by means of the integrating pulley of the work meter, which for this purpose is taken off the meter and used as a measuring wheel. The latter may be put on the upper or lower disc in such a way that it rests with a slight pressure on the test disc and rolls alongside it when the machine is in motion. On comparing the number of revolutions of the test disc and the measuring wheel before and after the test, the wear and tear can be ascertained. The test is performed either dry or wet. By the side of each test disc is an endless chain conveying the liquid and grinding material to the test discs.

Long Welded Pipe Line.—The new 28-mile pipe line of Butte, Montana, recently completed at a cost of something more than $1,000,000, carries water from the Atlantic watershed to a city on the Pacific slope. The line is composed partly of one-half inch thick, double-coated steel pipe, the sections being on the average 17½ ft. in length and weighing from 2,000 to 2,400 lbs., according to diameter. There are about five miles of the steel pipe in which the working pressures vary from 350 to 400 lbs. per sq. in. In one place a grade of 38 degrees is maintained for a distance sufficient to elevate the line 400 ft., and there is a lift of 800 ft. in a distance of 3,000 ft.—from pumping plant to standpipe. The construction of the pipeline required 1,125 tons of steel pipe. The reason for using welded construction was primarily one of efficiency, though it also resulted in a marked economy.

Practical v. Academic Inspection.

BY F. C. EDWARDS.

It will generally be conceded that no one can so effectively retard output as the inspector. He himself most nearly approaches the 100 per cent. mark in proportion as his rulings tend ultimately to maximum production with a minimum of scrap. As a corollary, it must be admitted that the inspector has it more completely in his power to make or mar the success of his firm than any other employee.

To-day the watchword is cheap production. The inspection of castings should, therefore, be based upon the sole requirements of the particular castings under inspection rather than upon general stereotyped formulæ.

Inspectors may be roughly divided into two classes, the practical and the academic. The difference consists, probably, more in their respective mental attitudes than in their intellectual attainments.

Inspectors of the academic type seem to be obsessed with the idea of inspecting "according to plan." For them the dimensions on the blue-point would seem to be as immutable as the laws of the Medes and Persians. They are, as it were, slaves to rigid accuracy, and they seem to lack the imaginative power which would enable them to realise that there is a vital connection between production and the continued existence of their firm. The rejection of work appears to afford infinite pleasure to this type of inspector.

The practical inspector, on the other hand, whilst equally lynx-eyed where essentials are concerned and adamant in his determination to allow nothing shoddy or detrimental to his firm's reputation to be passed, is, in addition, wide awake to the fundamental fact that output is the life-blood of his firm. He keeps this constantly in view in giving decisions, realising that he is more amenable to the general law governing every employee in the firm—that his functions connote, directly or indirectly, the promotion of output. In a word, he is employed to increase production—**not to retard it.**

Actual experience of both types of inspectors must lead to the conviction that the difference between them in worth to their firm is incalculable. The acadamic inspector, in making an uncalled-for use of irritants, as they may be termed, engenders an atmosphere of antagonism which seriously militates against harmonious working. The practical inspector, on the contrary, wins the whole-hearted co-operation of others, and thus secures for the firm their best efforts.

The writer calls to mind a case illustrative of the value of real practical inspection. A number of large cast-iron frames with slots cored out in each of the four corners for the reception, after machining, of steel bars of standard size, were rejected by the viewer in the machining department on account of the slot cores being slightly out of line: they would not machine up to receive the standard bars. It should be mentioned that the viewer had previously been under the control of a chief inspector of the academic type, and he took for granted that what was not strictly "according to plan" was useless. A new chief inspector had, however, shortly before been appointed, and he dealt with the case in a manner which showed that he belonged to the practical category. He proposed that in place of the standard bar for that particular size of frame the next larger size be used. This, of course, would permit the slots to be machined out larger, and thus brought into line.

The result was that the whole of the castings were made use of, with a considerable saving to the firm, and with no detriment whatever to the finished product. The customer really gained a slight advantage—the bars would wear longer—and replacements could be as easily supplied as those of the smaller size.

IN FACE of strong foreign competition, the Cleveland Bridge and Engineering Company, of Darlington, has secured contracts from the Union Public Works Department, South Africa, for the steel work for no fewer than twenty bridges. The weight of the 45 spans required will be approximately 4,400 tons, and the cost £200,000.

XUM

Foundry Work in Holland.

BY A CORRESPONDENT.

It does not appear possible that the foundries of Holland may be regarded in the light of competitors with ours, in spite of the fact that of recent years there has been some development in this branch of industry. Unfortunately for them, their minerals perforce must be imported, and although this is not an insuperable obstacle, additional discouragement is lent by the concentration of their near neighbours—the Belgians—in this direction.

So, whilst there is in Holland a certain demand for Dutch castings, the orders for the larger quantities go over the border, and the result is quite satisfactory from the buyer's standpoint, seeing that he can buy a superior casting much cheaper than he can buy a second-rate one in his own country.

It must not be inferred from this that it is impossible for the Dutch foundries to produce good castings, for the writer has seen some which will vie with some of the best produced in Britain or Belgium. Such instances are, however, rare, and in the main it may be said that the Dutch product is of a somewhat mediocre character—quite good enough no doubt for a variety of purposes, but expensive when price and quality are compared. The foundries of Holland seem to be no better (or worse) than those of this country, although there are isolated cases of modern buildings with an up-to-date lay-out, which are non-existent in Holland. The Dutch foundry is quite ordinary looking, and business is conducted in a happy-go-lucky fashion. The founder is a philosophical person—he is not angry, nor even surprised, that the large orders go to Belgium.

He takes orders for any quantity, but he realises he is but a convenience, and he charges accordingly. He does not believe in speculation, and the idea of quoting a low figure with a view to getting further orders does not occur to him. He will, however, bargain, in order to get more work. His price is given for the order about to be placed, but he is prepared to lower this considerably upon receiving an undertaking to give him further orders.

From an organising standpoint there is little to boast of. The "lay-out" of the foundry is quite unmethodical, and there is certainly plenty of room for improvement. Machine moulding is in evidence, but the machines, although many in number, are not of very modern design. In spite of this, however, there is no doubt that, properly utilised, these machines would be very effective producers; but just now the larger number are idle on account of insufficiency of orders.

The foundries visited by the writer were quite spacious, and could be put to very good use if properly developed. A thorough re-organisation would, however, be necessary, and the Dutch founder is not prepared to spend money, unless he can see some immediate return. He is deterred by the activities of the Belgians, who make no secret of their determination to undercut the Dutch founder.

The quality of the Dutch product leaves much to be desired, and the percentage of scrap is very high. The finish of the casting is rough and irregular, and many difficulties are experienced in subsequent machining. There is, too, a tendency to hardness, and although this is by no means peculiar to the Dutch casting, it may be said to be the rule rather than an exception.

It may be that metallurgy is not strongly developed, for there appears but little attempt at improvement. Scrap castings are replaced, but there are thousands of castings which are causing endless trouble, and yet cannot be labelled scrap—neither is there any recompense from the foundry. So far as hard metal castings are concerned, they must be made the best of, for even if these are returned to the foundry the replacements will be equally bad.

There seems to be no getting at the root of the trouble. Whether it is the abnormal amount of foreign scrap used, whether the mixing is at fault, or whether the sand is at the bottom of the trouble, it is by no means easy to decide. To questions on these matters the founder replies that (1) the scrap used is his own product; (2) he employs qualified men for work demanding skill; and (3) he has faith in the sand he uses. Research work would probably get nearer to the cause, but this does not appear to be resorted to, to any great extent.

The opinion of the writer is that the Dutch founder does not take full advantage of the many opportunities offered. Holland is developing rapidly as an industrial country, so far as engineering is concerned, and it would seem worth the while of the founder to make a bold bid for a much greater proportion of orders than he at present secures.

The article so far has dealt with iron founding, and in regard to non-ferrous castings it is pleasing to note that the product is quite good. Here the active competition of the Belgians is not so marked, and there is every incentive for the Dutch founder to go "all out" for business. In a country where shipbuilding and ship-repairing hold a dominant position there is a demand for non-ferrous castings, and so far as quality is concerned, these can be produced in Holland.

The non-ferrous foundries visited by the writer were remarkably clean and orderly, but there was little business, in spite of the vast amount of ship-repairing being secured by the Rotterdam firms, and in face of this it would seem that something is wrong if the foundries of the country do not feel the effects of this prosperity.

Surely it is up to the Dutch founder to exploit this branch of industry to the utmost, and, properly organised, there is reason to assume that the foundries could efficiently cater for all demands. The price, unfortunately, remains high, and it may be observed that, no matter how good the product may be, the buyer is not prepared to pay an exorbitant price for it, if he can get something slightly inferior, but equally effective, at a much lower figure.

As a country, Holland is small, and this, together with its efficient system of railways and waterways, makes the question of transport a very simple and inexpensive matter. The question of speedy delivery must always be taken into consideration, but this is a matter primarily of organisation. The requirements of the writer were promptly met, but this was at a time when the foundries were crying out for orders. Whether delivery could be so satisfactorily handled when industry is in a normal state cannot be pre-determined, but now is the time to organise with a view to making this possible.

Even in the case of non-ferrous castings, it is difficult to imagine the Dutch founder competing for British markets, but he should be able to hold his own in his own markets. At the present time, despite the high price of the Dutch product, and despite the fact that the rate of exchange is in our favour, the British founder has little chance of establishing himself in the Dutch markets. The real peril to the Dutchman is the German, who is making efforts in this direction, as in all others, but there is no reason why the Dutchman should not triumph, if he will take the trouble to do so.

This article has been written as a result of observations made, and is intended to be nothing more than an expression of opinion. The writer has visited several foundries and has conversed with leading officials. He has received quotations and has placed orders, and has been intimately concerned with subsequent inspection and machining of castings. He has had the opportunity of comparing price and quality of the Dutch castings with those of Belgium and England. So far as the British founder is concerned, there is a market in Holland, but it is unlikely that at the present time he can compete with the Belgian in the matter of iron castings, whilst the Dutchman himself can (if he is determined) hold the market for non-ferrous castings against all comers.

DR. H. S. HELE-SHAW, one of the vice-presidents of the Institution of Mechanical Engineers, delivered the "Thomas Hawksley" lecture to the members of the Midland Branch of the University last week. Dr. Shaw, whose subject was "The Transmission of Power from Oil," was naturally mainly technical in his observations. He dealt in interesting fashion with the various considerations arising out of the use of oil for engineering purposes, notably the problem of effective lubrication.

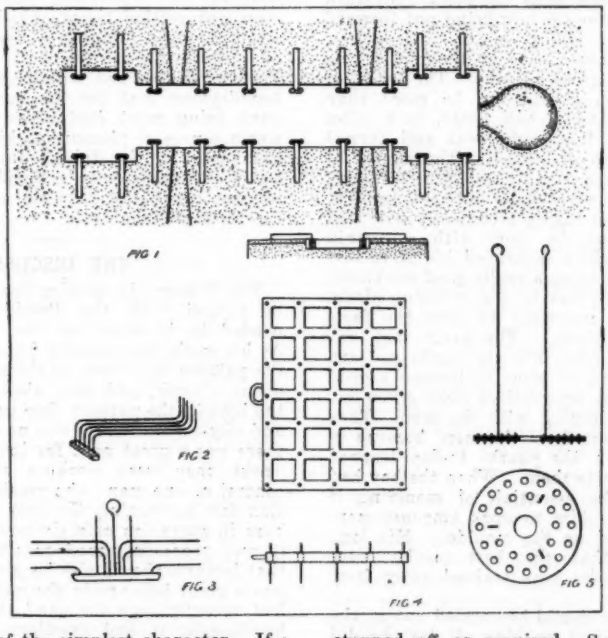
Points in Open Sand Moulding.

BY JOSEPH HORNER.

To make an open sand mould, it must be absolutely level, because the proper thicknesses depend for their parallelism on the mould being horizontal. Hence if this is not so, the pattern must be set in the sand with a spirit level.

A bed can be swept with a board attached to a central spindle, or when a floor wheel moulding machine is available, its centre can be used. After the bed has been swept, its socket is fitted with a plug, and the sand completed over it. Another way is to lay two parallel straightedges (winding strips) on the levelled floor, for their longitudinal direction, and set in transverse relations with two other parallel strips. A device not usual with open moulds, though common with bedded-in work, is that of strickling a thickness of facing sand over the levelled bed, the thickness being determined with two gauge strips set on the lower straightedges.

Even ramming obviates lumps in the casting, though for some purposes, as loam plates, these would not matter



The patterns are of the simplest character. If a plate is rectangular, a rough frame may be laid on the bed. The sand is rammed against its outer edger to form the walls of the mould. But often only a plain straight strip of wood is employed. The outline of the casting is marked on the bed, and the strip, set by this, is rammed against, and moved into fresh positions.

The thickness of the casting is determined by ramming the walls $\frac{1}{4}$ in. to $\frac{3}{4}$ in. deeper than the casting, and cutting gutters at the correct depth to allow the metal to flow off there, as it is difficult when pouring to determine the moment at which to stop.

If the walls of a mould are curved a sweeped piece is moved round from which successive sections are rammed. The sweeps are set by the lines struck on the sand bed, and are either weighted or held by one hand, while the other works the rammer.

When lugs have to be cast they are cut in the sand singly, their shapes being imparted by a pattern. When holes are required, cores are laid on the bed by measurement. Core prints are not used usually, the cores being secured in any convenient manner, such as loading with small weights, by overhanging bars as shown in Fig. 1, or by nailing down with a long sprig.

In Fig. 1, which shows a mould of a back plate for a moulding box, the oblong cores are for bolt holes.

Prods are cast on many loam mould plates. Generally, they occur on one side only, and the pattern prods are mounted in a strip of wood, provided with a handle.

Gaggers, or portions of built-up grids, when required in large numbers, are plated, several are set on a board, and pressed into a levelled bed. Roughness is an advantage, because it assists the adhesion of the sand.

For rough weights for loading flasks, and smaller core plates for keying on core bars, full patterns are used. For many of the latter iron patterns with the lightening holes cast in are used.

Weights with lifting eyes must have a print, for the core that carries the lifting loop. The eye is forged, and rammed in the core, which lies in the bed. The upper faces of weights cast in open sand are rough, so that it is better to cover these with a top, though the weights themselves are moulded in the floor without a flask.

As perforated core plates used on core bars for making cylindrical cores have usually to be broken up when extracting the core, they are in frequent demand. The perforations and thinness ($\frac{3}{8}$ in. to $\frac{1}{2}$ in. thick) favour the breaking up. Prods are not wanted except for end plates, in which case they face outwards to hold the loam there.

Common forms of grids are often moulded from a standard iron or wood pattern, extended or stopped off as required. Sometimes the moulder cuts out suitable shapes on a levelled bed, by the guidance afforded by the core box laid on the bed, within which the grid outlines are marked, the grid mould being shaped simply with a trowel and a cleaner. If an eye has to be cast in, it is carried and supported vertically with a rod passing through the loop and resting on bricks or weights flanking the open mould. Eyes and rods have to be cast in many grids. Fig. 2 is one for a large passage core for a cylinder. The only part cast is the strip which has to go into the print end of the core. The bent rods are stood up in the mould, being pushed very slightly into the sand, and are supported in the horizontal position on a trick, and weighted, and the metal is poured round their ends. In Fig. 3 rods and eyes are cast into a plate and are treated similarly to those just described.

A form of grid frequently used is that shown in Fig. 4, having rods standing out on both sides, and an eye cast in the edge that will be in the top of the core, and by which it will be lifted. The rods require no other support than that afforded by pushing them into the sand bed as far as they have to project on one side. Fig. 5 is a central core plate for a loam mould with three long rods cast in it with which to lift the bricked-up core. These are supported in the ring mould with rods going through the eves, and carried on baulks of timber or bricks. The plate has holes cored, and prods cast on both sides, so that the mould must be closed with a cope or with a loam cake.

XUM

Institution of British Foundrymen.

SHEFFIELD BRANCH.

At the opening meeting of the session, held on October 21, MR. JOHN WATSON, the newly-elected Branch-President, occupied the chair. Mr. Watson was elected to the Branch-Presidency in his absence, and the meeting was his first appearance amongst his old colleagues, who accorded him a very hearty welcome.

THE PRESIDENTIAL ADDRESS.

The Apprenticeship Question.

MR. WATSON prefaced his Address by thanking the meeting for the honour they had conferred on him, and called the attention of the members to the very attractive programme which warranted a good attendance at the future meetings. He would like to bring to their notice one or two things which in the near future were sure to be discussed by the General Council, and these were matters upon which every Branch should express its opinions. There was, first, the old question of apprentices and how they were to obtain competent workmen. To some that might appear to be a question which had been thoroughly thrashed out, but much nonsense was now being put forward about the technical education of apprentices. After twenty years' experience he thought a long apprenticeship was a great mistake. The period of training in the shop should not be more than from four to four and a half years, and after that period he should be competent and turned adrift to make a man of himself. The age of 14 years was the best time to get a lad into the shops. At 16 a lad's ideas were changing very rapidly, and when he had been highly technically educated he usually came into the shop with a certain amount of conceit, which destroyed his usefulness and his chance of becoming a really good workman. It must not be taken that he was without ideals, but after all it was necessary to keep the facts and realities before them. The great fact was that a boy or man went into the works to earn money for himself and to learn to become a good workman. At present apprentices were given far too much liberty in mixing with the men. They should be trained apart from the men, because in nine cases out of ten the youths to-day learned much that was no use to them. When the boy had been grounded in the essentials of moulding it was then the time for him to work amongst men, to learn how to build up the moulds. His long experience showed that the best results were obtained from boys who were trained away from the men.

Technical education should be carried out at the works. When a boy was working all day he did not feel inclined to go to the technical college whilst his brother went to the pictures. Not more than one in every 100 lads went to a technical college for the sake of instruction. The majority went because they were forced to do so. The result was they got a smattering of knowledge which was no use to them. He thought the better plan would be to give a lad a certain amount of instruction each day in the works in technical subjects, and show him when a thing arises how his technical knowledge would help him. It could there be better explained to him why, for instance, certain jobs were run one particular way. He should be told that technical knowledge alone was not going to make him a good workman and one qualified to earn his livelihood. Some may think that that was a waste of time, but it was a greater waste of time to learn technical subjects outside the shop.

The Production of Castings.

In the Institution of British Foundrymen anything that savoured of politics was out of order, and they were entirely concerned with the technical side of their business. But they must see what was happening all round them. Unless a larger production per man was to be obtained from British foundries they would put themselves out of the world's trade. Foundrymen could aid in the matter of production by "hammering away" at buyers to simplify their castings. If designers would only work hand-in-hand with the practical foundryman much work which now has to be made by hand could be made by machinery. If this were done eventually most of the present day foundry work would be done by machines. Big strides had been made in the use of the machine in the moulding shop, and before long he believed there would be greater strides still. One of the first things that would happen was that the ramming machine would be entirely superseded. Quite recently he had studied a novel kind of machine in which there was neither ramming nor jarring. The sand was projected into the mould and an excellent mould with a good face was obtained. It was a new development, and should be watched. He was hopeful that the British workman would see that it was better for himself that he should be paid on results. If he were they would soon regain a hold on the world's trade.

Continental Conditions.

In France they were working very hard. The product was excellent, the prices lower than those prevailing in this country and, moreover, the foundries were full up. They were making money and the men were working very hard. In Belgium the men were working harder than in 1914. All that was very disturbing, but he hoped they would soon get settled times, which would come about when the men themselves realised the importance of output. Since he had returned from New Zealand he learned with pleasure from a British foundryman that the few men who were working were doing much better than in the past. That was a source of pleasure to him, because he had a great love for the British workman, and after his ten years' experience in Sheffield he did not know of men capable of turning out better work than the Sheffield moulders.

THE DISCUSSION.

MR. DARLEY, in opening the discussion, said that he agreed with the President that something needed to be done on the apprentice question. At his works the foundry apprentices and those in the pattern shop went to classes two or three afternoons a week, and they also effected exchanges—the boys in the pattern shop going into the foundry and *vice-versâ*. There was no doubt, however, that there was a great need for improvement. In their works they were working the boys under the control of one man, who received extra remuneration for instructing the lads. The practice had been in operation only six months, but he believed it was producing good results. It was intended that lectures should also be given to the boys. He was a great believer in the moulding machine, and had recently seen the sand thrower at work, and he thought it had excellent points. The chief objection was the dislike of the workmen to them. He failed to see the reason, because it obviated much hard work. Until the men were prepared to work by results he was afraid the moulding machines would not get a fair chance.

Moulding Machines.

MR. BRADLEY, after endorsing the President's views on the subject of apprentices, said that in some cases employers wanted to get too much from the boys instead of teaching them how to work properly. With reference to moulding machines eliminating a certain amount of labour, at his works they were not getting the hoped for results from the machines, but perhaps with a little more experience in their handling they would be able to get good results in the future. He could say, however, that the men were working much better now than in the past.

MR. DAWSON said he was not capable of expressing an opinion on the apprenticeship question, but he thought that what the President had stated with regard to what was happening in France and Belgium was right from what he had seen himself. There was no comparison in the way the French and the Belgian workmen worked with the British.

Technical Classes at the Works.

MR. SHAW, after thanking Mr. Watson for his address, said that the apprentice question was a vital one, but it had two aspects if Mr. Watson's ideas were put into force to which he desired to draw attention. The first was that the employers

might simply use these boys to cheapen production. That was not fair to the boys. Again, the employer who might give the technical tuition during the day time and pay something specially for supervision during his moulding time might leave at the end of four and a half years, just when the boy became most useful. That obviously would not be fair to the employer. He thought the only way to obtain the special training was to make it compulsory for every employer to give special technical training for so many hours per week up to 18 years of age. It would also tend to make good citizens if a portion of the boys' time was devoted to the study of economical questions. With regard to production, the use of moulding machines was generally restricted to repetition work. To cope with either American or Continental practice, semi-skilled workers should be employed at least on the ramming, even if the finishing and closing were left to the moulders. The very lack of apprentices would force the more extensive use of machines eventually as it had done in America. The teaching of apprentices is compulsory in Germany.

Faulty Systems.

ENGINEER CAPT. MOORSHEAD, R.N., said that he was not well qualified to speak on the subject of foundry apprenticeship, because there were many difficulties in such training that did not obtain elsewhere; he had, however, had considerable experience of general engineering apprenticeship.

He called to mind two particular cases in large firms. In one, where premium apprentices were taken, the firm definitely stated they undertook to teach them nothing; in the other, where the premium bonus system was successfully in operation, the apprentices were exploited to increase production without regard to training.

Such methods were of the past, for if boys were brought into the works and regarded as merely commercial machines to get as much out of as possible, they must dismiss the question of any improvement. That was not playing the game with the boys.

With regard to the point the Branch-President referred to of allowing them to work with the men, they must not overlook the fact that any proper training must be on systematic lines and methodically carried out under ample supervision, and just detailing a boy to work with a man did not meet the case.

Definite theoretical instruction was necessary during working hours, and this insured a certain general standard, but should be regarded as subsidiary to the important technical instruction that was available in a city like Sheffield.

As regards age, the President suggested 14; he thought 16 was early enough, and the two years' extra school education was important.

The late Lord Fisher's idea in introducing the new scheme of training of officers in the Navy was that an early age of entry was most important, but this has subsequently been modified and a later age adopted, while a system of entering public school boys at 17 or 18 had been attended by most successful results.

MR. BRADLEY said with regard to the question of educating the apprentices classes had been formed at Messrs. Osbornes & Doncasters. There the boys were taught during working hours in a school, and were paid for their time.

COVENTRY BRANCH.

Discussion on Mr. J. E. Bates' Paper on "Some Notes on Pattern Plates."*

THE CHAIRMAN (Mr. G. E. Roberts), in inviting discussion, said that he thought they would all agree that there was plenty of food for thought in what they had listened to that night.

MR. C. DICKEN (Vice-President), after expressing his interest in the lecture, asked three questions. (1) What metal did the author consider the best for pattern plates? (2) What clearance did he consider should be allowed in pin holes to bring out a perfect casting, say a round job 12 in. deep and cut in halves? (3) Did the author advise that a 5,000th part of an inch clearance was the best to work to for pattern plate making, and was it sufficient for cheap jobs? So far as sectional plates were concerned, some twelve years ago, he believed, there was one brought out by Wilkinson and patented, which was somewhat similar to the one which had been described. Further, did the lecturer think it wise to draw a hard and fast rule with regard to the master runner? A master runner for different jobs was in his opinion not a good practice. Every job should have a master runner of its own. Also, had the lecturer any experience of V-shaped pins? Such pins, he believed, were used in the most up-to-date works, with an adjustable nut in the back of the pin hole as used on the box part, so that in case of any variation in the pin hole, or wearing of the pin hole in the box part, it was overcome by an alteration of the register.

MR. F. H. HURREN, A.I.C. (past Branch-President), remarked that one thing in particular had struck him. He would like to know what exactly were the advantages in the sectional plate, as it seemed to him that this method was rather an expensive one, even for small repetition orders. It occurred to him that to prepare sectional plates, which were undoubtedly ingenious, it was necessary to use rather a large box, and he should have thought that for small repetition orders it would have been cheaper to have made a single plate and use a small size box. The lecturer did not refer to plasters, and for cheapness the plaster pattern plate could not be beaten, but, unfortunately, it was fragile. The universal box which Mr. Bates mentioned was certainly quite unique to him, and one which he thought was capable of great development. Like Mr. Dicken, he could not quite see the value of the master feeder and of placing all their patterns on the plate to suit the feeder, whereas the feeders should be made to suit the patterns. Plates for three- or four-parted jobs, and the details of manufacture of some really intricate castings would have formed an interesting section of the Paper. The lecturer suggested pins and lugs should be case-hardened, and it would be interesting to know the effective life of the parts so treated. It was found that even with a case-hardened pin after a considerable time in the shop they showed a certain amount of wear.

MR. ABRAHAM asked what the lecturer considered to be the cheapest method of making a plate for a pattern with 100 to make up?

The Lecturer's Reply.

MR. BATES, in reply to the points raised, stated that the composition which he had found most useful for metal for the purposes he had described was 85 of lead, 10 of antimony, and 4 or 5 of tin. If they desired to cheapen the metal a little, then they could drop one of tin and substitute one of antimony. With this metal he had found the contraction very constant at 1/32nd of an inch per ft. By introducing bismuth the contraction could be reduced very considerably, but, unfortunately, at the same time, the cost was appreciably increased, because much bismuth had to be added to make any real difference in the contraction. Mention had been made of boxes, and a suitable tolerance for pins on boxes of 6-in. deep. He thought that for close-jointed work, even at that depth, they should attempt no more than 0.010 in. clearance. The suggestion that a sectional plate had been placed on the market by Wilkinson led him to remark that if, if he was correctly informed, this sectional plate depended for location on a V-groove. The lecturer said this sectional plate was cast with a male V, and then the frame fitted on the machine had a female V. The obvious objection to this was that they were depending on the contraction for their location. In this instance the plate had a male V, and the end of the frame was open, and they were slid in. There was no means except the contraction for getting the side location. There were no means at all in this method except by putting each plate against another to get the end location, which did not seem a very desirable method to adopt. Further, this particular article of Wilkinson's only referred to double-sided plates. Personally, he did not see how it could possibly refer to a transfer sectional plate. Another objection was that if there were four plates all sliding into this frame and No. 1 was completed, in order to remove it, Nos. 2, 3, and 4 had to be taken out first. Now by using those which he had shown with the pins on the frame,

* See page 415.

each one was entirely independent and could be separated and removed without disturbing any of the others. With reference to the master runner being unnecessary, he insisted that in a number of cases, probably 20 to 25 per cent. of these plates, these master runners could be used. Master runners were *not* good for every type of plate he had made—it all depended on the job. The master runner had its limitations, but within them it could be used to advantage, always being sure that the section of the master runner was on the heavy side. He did not think he would be justified in displacing his diameter pins by V-shaped ones, as he had not had much difficulty with the former. With reference to the expense of sectional plates, a box of 14 in. × 11 in., arranged in three sections, would allow for each being about 4½ in. wide. In the transfer plate they had a pattern plate, moulding a box of a size 4½ in. × 5½ in., and he suggested that to make a plate and using such a box was not an expensive operation. He did not know whether it was the practice to use very small boxes on the machine; the smallest boxes he had seen used to any extent were 12 in. square, assuming that the 14 in. × 11 in. size was one of the smallest boxes used. Then for a small job or order, such as 100, provided it would go in that section of 4½ in. width, the cheapest way was to make a sectional transfer plate. As to the life of case-hardened pins, when using ordinary pins, they were having to be frequently replaced; since introducing the case-hardened pin, some a year ago, he had had to replace none, and the resultant castings were quite good in respect to the jointing.

The lecturer understood from Mr. Dicken at the close of the meeting that the composition of the metal which showed a contraction of only half a millimetre to the foot, was 50 per cent. lead and 50 per cent. tin.

A vote of thanks to the lecturer closed the meeting.

Annealing Practice.

A large attendance of metallurgists connected with the Birmingham Branch of the Institute of Metals discussed the question of annealing at their monthly meeting on Tuesday, November 8. The discussion followed a Paper on the subject by the President (Dr. Brownsdon), in which strong emphasis was laid upon the lack of fuel economy, and the inefficiency of some of the furnaces, at Birmingham works. In the course of the discussion several suggestions in the way of effecting improvement were made.

MR. A. J. G. SMOUT pointed out the great scope for fuel economy, even in the most modern type of muffles. He thought that the supply of gas from a producer serving one or a group of furnaces was probably the best method of using coal. Visiting lately a number of German works in the Occupied Area, he was astonished at the success with which lignite and other low-grade fuels were utilised in furnaces of the producer type worked on the recuperative or regenerative system. In spite of great improvements that had been made in furnaces and in annealing practice, they still wanted furnaces of better design, while more training should be given in the highly scientific operation of annealing.

MR. SPITTLE pointed out that lack of fuel economy was due at many works to the fact that they only operated nine hours with the usual meal-time intervals. High economy could only be got by continuous operation. He was inclined to think that high-class coal, in spite of the price, was the most economical. During a recent visit to America he found all the annealing done by means of oil, except in one furnace heated by electricity, while an ingenious type of furnace passed the heat on from metal already heated to blooms requiring to be re-heated.

MR. R. J. READING gave interesting particulars of experiences during the war at the Government copper-rolling mills at Southampton. He related how he had to train men entirely ignorant of annealing by improvising lectures in which he told them how to anneal, manage pyrometers, and stoke their furnaces, with the result that they attained great perfection in the treatment of the metals. He strongly condemned the system of getting gas from a central producer, which he said wasted a substantial amount of the sensible heat.

MR. E. A. SMITH pointed out the great use of salt bath annealing, which had been very successful in steel work, and had lately been applied to non-ferrous work.

DR. HUTTON, of Sheffield, advocated the more extended use of the electric furnace, and the PRESIDENT strongly urged metallurgists to set to work and improve their own furnaces without waiting for a designer.

A New Jolt-Ramming Machine.

An interesting patented electro-hydraulic jolt-ramming machine was exhibited at the Liége Foundrymen's Convention by the S. A. des Etablissements Ph. Bonvillain & E. Ronceray, Paris, and 97, Queen Victoria Street, London, E.C.4. The general appearance of the machine with the electric motor and the reduction gear is shown in Fig. 1. The machine can, of course, be belt-driven. The interior of the machine is shown in Fig. 2, the photgraph being taken from above.

The principle of this machine is novel, and differs

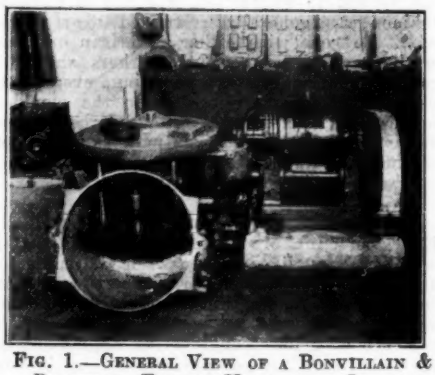


FIG. 1.—GENERAL VIEW OF A BONVILLAIN & RONCERAY ELECTRO-HYDRAULIC JOLT-RAMMING MACHINE.

materially from the normal jolt-ramming machine. The shaft actuated by motor or pulley gives by means of a convenient arrangement of cranks and connecting rods an alternating motion to the cylinder shown at C, Fig. 2. The stroke of this cylinder is constant, and the number of strokes is 400 per min., and is the same as the number of revolutions of the shaft. This cylinder is traversed by a piston B (Fig. 2) having in its centre an enlarged part, so that it leaves between it and top and bottom of cylinder an annular space.

The two annular spaces so formed communicate with each other through channels which can be more or less choked by screws D, Fig. 2. A convenient arrangement is provided to send, when required, a stream of water through these channels.

If there is no water, air can pass from one side of the piston to the other, leaving the piston of the machine practically motionless, even though

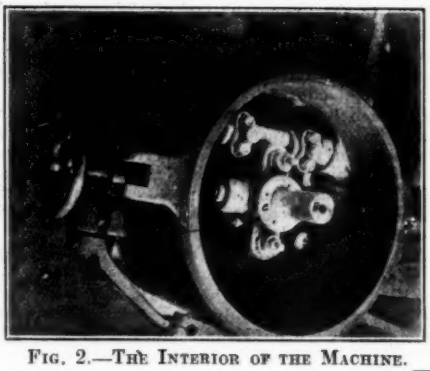


FIG. 2.—THE INTERIOR OF THE MACHINE.

the cylinder is moving at normal speed. But, if water is admitted, it forms a cushion between piston and cylinder in such a way that the stroke of the piston varies with the amount of water admitted.

The speed of 400 strokes per min. is sufficient to avoid the rebounding of the sand, which is a drawback of most jolt-ramming machines. The machine works similarly to a double-acting steam hammer, the blow being obtained not only by the gravity but also by the pushing-down action of cylinder through the cushion of water. Consequently, a short but very effective stroke is obtained, and the objectionable rebounding of sand done away with.

A pattern-drawing device of simple design can be applied. The machine has been especially designed with the view of ramming a few moulds on wooden patterns, and is admirably adapted for this purpose. Its lifting power is about 1,400 lbs.

Company News.

Henry White & Company, Limited.—Capital £100 in £1 shares. Registered office: Pontymister Foundry, Pontymister, Mon.

John Brown & Company, Limited.—Interim ordinary dividend, fully paid, 6d. per share; part paid, 4½d. per share, less tax.

Midland Iron Company, Limited.—No further dividend on ordinary shares, making 5 per cent., tax free, for year; preference dividend paid for year.

Brookes & Doxey, Limited.—Interim dividend, 4½d. per share; bonus, 9d. per share. Latter applied in payment uncalled capital, making shares 16s. 6d. paid up.

Atlas Steel Foundry & Engineering Company, Limited.—Profit, £14,780; brought forward, £4,765; depreciation, £5,000; general reserve account, £2,500; dividend, 7½ per cent., free of tax, £5,625; carry forward, £5,438.

A. Roberts & Company (Leeds), Limited. — Capital £2,000 in £1 shares. Machinery merchants and agents, etc. Directors: D. L. Roberts, F. L. Roberts, and W. L. Roberts. Secretary: F. L. Roberts. Registered office: 15, Queen Street, Leeds.

Lancashire & Yorkshire Wagon Company, Limited.—Profit, £8,287; brought forward, £6,668; dividend, £4,200; reserve, £2,500; interim dividend, £2,799; credit of profit and loss account, £12,155; deducting dividend already paid (£4,200), balance (£7,955) carried forward.

Fairbanks Company (Europe), Limited. — Capital £100,000 in £1 shares, to adopt an agreement with the Fairbanks Company, U.S.A., and to carry on the business of weighing-machine manufacturers, etc. Directors: N. J. Wallworth, G. Millar, R. E. Post, T. E. Hazell, R. S. Golding, and A. Adamson. Secretary: Miss M. L. Leask, 45, Hamfrith Road, Forest Gate, E.

Cargo Fleet Iron Company, Limited.—Balance of profit at September 30, 1919, £220,458; ordinary dividend paid December 31, 1919, 5 per cent., £50,000; depreciation, £75,000; general reserve, £50,000; carried forward, £45,458. Report for 1920: Depreciation, £50,000; debenture interest, £42,130; balance, £180,634; dividend, 5 per cent., less tax, £50,000; carry forward, £130,634.

South Durham Steel & Iron Company, Limited.—Dividend, 10 per cent., less tax; profit for 1920, £247,365; brought forward, £44,481; available, £291,846; interest on debenture stock, £13,500; dividend on 6 per cent. cumulative preference, £13,500; interim ordinary dividend, 2s. per share, £35,000; depreciation, £50,000; final ordinary dividend, 3s. per share, making 25 per cent. for year, £52,500; dividend on 6 per cent. cumulative preference, £4,500; carried forward, £122,846.

Crookes, Roberts, Ritchie & Company, Limited.—Capital £80,000 in £1 shares, to take over the business of a manufacturer of guillotine machine knives, rag engine roll bars and bed plates, high-speed and crucible steel, etc., carried on by W. J. Ritchie, as Crookes, Roberts & Company, at the Argus Works, Shoreham Street, and as W. J. Ritchie & Company, at the Freedom Works, John Street, and Arundel Lane, both in Sheffield. Directors: W. J. Ritchie, W. Ritchie, and A. Crookes. Secretary: M. E. Broadhead. Registered office: Argus Works, Shoreham Street, Sheffield.

Personal.

THE LATE Mr. J. W. Crosthwaite, managing director of the Crosthwaite Engineering & Furnace Company, Limited, Leeds, left £16,661.

MR. C. Row, of Messrs. Lamberg, Gibson & Row, Bishopsgate Street, E.C., iron and timber merchants, who died on July 12, left £13,263.

THE LATE Mr. Wm. Burnyeat, J.P., who was associated with many of the mining and iron undertakings absorbed by the United Steel Companies, Limited, left £36,799.

MR. S. H. BYASS, J.P., the Mayor of the newly-created borough of Port Talbot, is the principal proprietor of the Mansel Tinplate Works, Port Talbot. He was Mayor of the now defunct borough of Aberavon for the past three years.

MR. A. S. WARD, president of the London Scrap Iron and Metal Merchants' Association, has been re-elected president of the Federated Associations of Scrap Iron, Steel, Metals and Machinery Merchants of Great Britain for the ensuing year. The following vice-presidents have also been re-elected: Mr. S. Bamber, of the Scrap Iron, Steel, Metals and Machinery Merchants' Association (North-Western Area), Manchester; Mr. W. S. MacLellan, of the Scottish Iron and Steel Scrap Association, Glasgow; Mr. T. Hickey, of the Yorkshire Scrap Metals and Machinery Merchants' Association, Leeds; Mr. G. Levy, of the London Scrap Iron and Metal Merchants' Association; Mr. P. M. Martin, of the Scottish Non-Ferrous Metals Association, Glasgow; and Mr. R. T. Hughes, of the North of England Association of Iron, Steel and Metal Merchants, Sunderland.

THE ANTI-ATTRITION METAL COMPANY, LIMITED, founders and engineers, Glengall Works, Glengall Road, London, S.E.15, inform us that they have closed their City offices, at Cornwall Buildings, 35, Queen Victoria Street, London, E.C., and have opened more extensive premises at 1, Victoria Street, Westminster, S.W.1.

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SIROCCO
...MARK...

CENTRIFUGAL FANS

For Supplying Blast to

Cupolas and Forge Fires.

Made in a large variety of sizes and suitable for pressures up to 30-in. W.G. The Fans have cast iron casings and the belt driven type are fitted with Ball Bearings.

Send for particulars to:—

DAVIDSON & CO., LTD.,
Sirocco Engineering Works, Belfast.

AND STEEL MARKETS.

Pig-iron.

There is no improvement to report in the previous stagnant conditions in the pig-iron trade, business in all sections continuing on a very restricted scale, with only a poor prospect of any increased activity during the closing month of one of the most disastrous years experienced in the history of the industry. Demand for pig, if anything, becomes more attenuated each succeeding week, and with markets only poorly attended movements, as a rule, are without special significance. Buyers still maintain a waiting attitude, a tendency doubtless due to the steadily diminishing prices for pig-iron, which it is perhaps rightly surmised have by no means yet reached the lowest levels possible in the circumstances now prevailing. Consequently transactions recorded represent the minimum quantities of iron necessary for immediate use, quite insufficient as an accurate test of market values. In the Midlands only a few furnaces are in blast, many plants standing idle on the grounds that production is unprofitable. Quotations for all brands are again on the down grade, Derbyshire No. 3 offering at 102s. 6d., forge at 97s. 6d., and Northamptonshire forge at 95s. The continued stagnation in the West of Scotland pig-iron market is unrelieved, foundrymen's demands having almost reached the diminishing point, their purchases now being chiefly confined to 10- to 20-ton lots at a time. Even in Continental iron, however, there is not much business passing, as consumers put fair quantities into stock in case of an import duty being imposed on foreign iron. At Middlesbrough the outlets for the disposal of the product of the Cleveland blast furnaces are undeniably limited, owing to the relatively high price and the undercutting by outside makers to which allusion has been made having had an adverse effect upon the already much restricted local trade. Cleveland makers, however, are in no mood to make further concessions, and the position will have to improve before there is any cut in prices or any expansion of output. Current quotations are: No. 1 Cleveland, 115s.; No. 3 G.M.B., 110s.; No. 4 foundry, 105s.; No. 4 forge, 100s.; mottled, 97s. 6d.; white, 95s. East Coast hematite No. 1, 112s. 6d.; mixed numbers, 110s.

The position in the hematite branch of the trade is greatly different. Here quotations are lower than any other. Welsh hematite, for example, is quoted 20s. per ton more than East Coast mixed numbers, and the result is that a good deal of Tees-side iron is still going to South Wales. Still, that does not absorb all the output and makers are keen to find fresh markets.

Scrap.

Entering on the final month of the year there is little fresh to add in relation to markets for scrap metal, in which the demand continues very limited, if not actually stagnant as far as bying in bulk is concerned. At Middlesbrough there is practically no change in the scrap position. Heavy steel scrap is nominal in this district at 57s. 6d. to 60s., but there is activity in the Welsh market, where as much as 67s. 6d. to 70s. has been paid for furnace sizes. There is a little doing in steel turnings at 40s., but c.i. borings are not in request, and the quotation is weak at 39s. per ton. Heavy cast-iron machinery scrap is a dull market, only 87s. 6d. to 90s. offering for the best descriptions, while ordinary material is only about 80s. Bushelling scrap is down to 57s. 6d., and good forge iron is nominal at about 80s. These are all delivered prices.

Finished Iron.

Movements in the markets for finished materials, if not more active at the moment, are certainly more interesting as indicating a further downward trend in prices, which, while recognised as ultimately inevitable, were hardly to be anticipated before the turn of the year. Association bar-makers for some time past have experienced considerable undercutting of the authorised prices for unmarked qualities, and last week at Birmingham announced their decision to reduce quotations by 30s. per ton for both best and ordinary brands, South Staffordshire now coming into line with other provincial producers. Their new list of quotations now reads:—Marked bars, £16 (net f.o.t. makers' works). Crown bars, £13; gas strip, £15 (both net delivered Birmingham area). Unmarked bars for nut and bolt and hurdle making have been offered at £13 5s., and latterly at £13. Last week another move was made by the Lancashire Association. They lowered their basis to £13 for their own district and for export, and the Staffordshire makers have followed suit. Rollers of common bars in Scotland have also reduced their price to £12 10s., and Lancashire iron hoops are down £1 to £16 10s. These prices are for local delivery. For the export trade the basis is 5s. less.

Steel.

The general tone of the steel trade has now relapsed from its recent optimistic tendency to quite a different mood, the abrupt suspension of preparations for the great Admiralty undertakings previously authorised having had an almost paralysing effect upon the industry in all the great centres of production chiefly interested in the projected work. The threatened cancellation of the contracts for three battleships, which were to have been built on the Clyde, has especially caused disappointment in this district, as not only would shipbuilding employés have been benefited, but a fair amount of work would have been provided in the manufacture of materials. It is reported that English steelmakers are selling shipplates in Scotland, including carriage, at £9 10s. The Scottish price is £10 10s., but it is believed that makers would accept less. Only a small proportion of the steel plant is working. Black steel sheets and galvanised material are very quiet. At Sheffield business continues slow in most departments, and the prospect is regarded with some anxiety, among the few exceptions being the branches catering for the motor industry, which, stimulated by the successful sales at the recent show, are placing fairly good orders for steel material with local works. Some orders are also in hand for railway material, but mills, on the whole, are only running irregularly, or are idle altogether. The position in high-speed steel continues unsatisfactory, the small amount of current buying being readily met from Government surplus stocks. Makers of heavy steel material are also suffering from the general depression, but with prices steadily declining it is hoped that a recovery will be possible after the turn of the year. The slump in the shipbuilding industry is also an adverse factor in the situation as regards makers of certain classes of tools, and is consequently disappointing from the standpoint of general trade, which is much below the average in most departments catering for Christmas requirements.

Metals.

Copper.—The week's markets for standard copper, under the influence of stronger American cable advices, have maintained an exceedingly steady tone throughout, fluctuations in values having been confined within quite fractional compass, indicating the stability of the position. Buying on forward account has been fairly good, December dates selling at £67 2s. 6d., while there also has been a well sustained demand for cash metal. January was done at £68 to £68 10s., with February deliveries at the same quotations. Refined sorts were also steady, electrolytic ruling at £75 10s. and wire bars £76 10s. Closing prices:—Cash: Wednesday, £66 15s.; Thursday, £66 12s. 6d.; Friday, £66 15s.; Monday, £67 7s. 6d.; Tuesday, £67 10s. Three months: Wednesday, £67 12s. 6d.; Thursday, £67 15s.; Friday, £67 15s; Monday, £68 7s. 6d.; Tuesday, £68 10s.

Tin.—Anticipation of improved deliveries of tin during the past week has strengthened markets to a great extent, and a heavier turnover has resulted, with prices consequently appreciating to a substantial amount. Week-end Eastern cables advising that holders in Penang and Singapore were declining offers of £164 5s. c.i.f., combined with favourable American reports, imparted further strength to the position, and considerable covering by operators on forward account resulted. Closing prices:—Cash: Wednesday, £160 10s.; Thursday, £160 10s.; Friday, £161 10s.; Monday, £163 10s.; Tuesday, £163 5s. Three Months: Wednesday, £162 5s.; Thursday, £162 10s.; Friday, £163 10s.; Monday, £166 5s.; Tuesday, £165.

Spelter.—The tendency in the spelter market of late has been distinctly firmer, any change in quotations being usualy to higher levels, with sales of metal showing a fair turnover. November has been done at £26 7s. 6d.; December at a similar value, and January at £26 12s. 6d. Closing prices:—Wednesday, £26 2s. 6d.; Thursday, £26 10s.; Friday, £26 10s.; Tuesday, £26 15s.

Lead.—The activity noted in this metal recently is well maintained, some exceptionally heavy buying being a feature in the week's markets, consequently there was a steady all-round advance in good soft foreign pig, near dates appreciating 7s. 6d., with metal on forward account 10s. higher. English lead was in good demand, and showed a further advance of 15s. English closing prices:—Wednesday, £26 5s.; Thursday, £26 5s.; Friday, £26 15s.; Monday, £27; Tuesday, £27.

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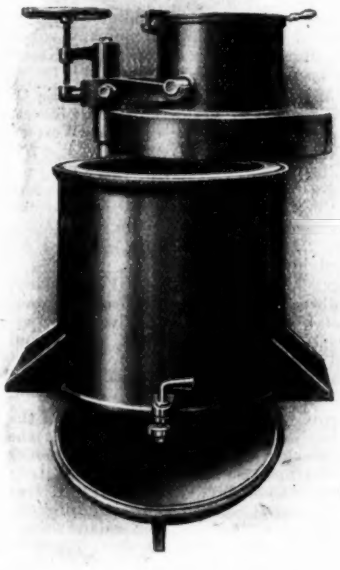
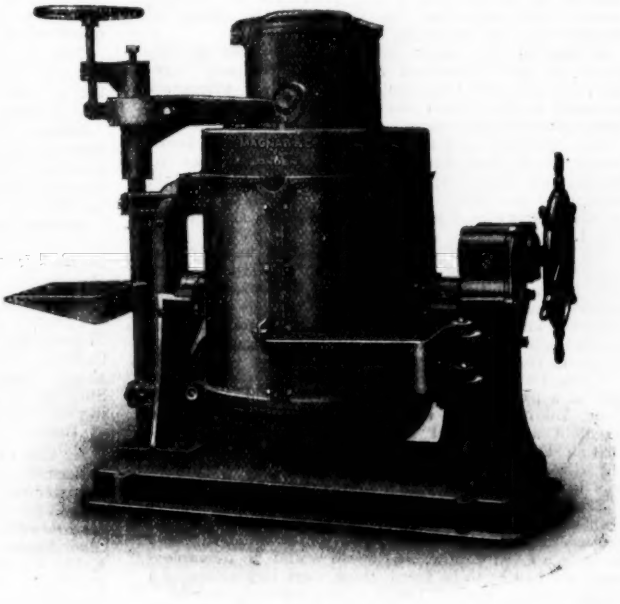
METAL MELTING CRUCIBLE FURNACE

For Brass, Gunmetal, Aluminium, Iron, etc.

Reduce your fuel cost! **Melt in a hurry!**





Tylor Patent Pit-Type Furnace.

OUTPUT.
200 lbs. Admiralty Gunmetal melted in 35 minutes. Temperature 2000° F.=1093° C.

ECONOMY.
25 lbs. of Coke used per 200 lbs. of Metal melted.

STANDARD CRUCIBLES.
Lasting 35 to 40 heats.

Tylor Patent Tilting-Type Furnace.

OUTPUT.
450 lbs. Admiralty Gunmetal melted in 50 minutes. Temperature 2000° F.=1093° C.

ECONOMY.
80 lbs. of Coke used per 450 lbs. of Metal melted.

STANDARD CRUCIBLES.
Lasting 30 to 40 heats.

56/8, EAGLE STREET, SOUTHAMPTON ROW, LONDON, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

Trade Talk.

A FURNACE has been damped down at Ulverston.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, have secured the contract for new boilers for 50 locomotives of the Russian Soviet Government.

THE METAL TRADERS' ASSOCIATION have decided to include dealers in waste materials as members, and in future will be known as the Metal and Waste Traders' Association.

THE ORDER FOR TWO LINERS for the Netherlands Steamship Company has been placed with Continental firms, at prices stated to be 20 per cent. less than the lowest British quotations.

MR. F. H. BRUGES (of Guest & Chrimes, Limited, Rotherham) read a paper before the members of the Rotherham Technical Institute Engineering Society, on November 19, on "Water Mains."

AN INTERESTING ACCOUNT of the machinery used in floating docks was given by Mr. E. H. Salmon, in a paper read before the members of the Institution of Mechanical Engineers on November 18.

THE VICTORIAN ELECTRICITY COMMISSIONERS have accepted the tender of Redpath, Brown & Company, Limited, Glasgow, for the supply of steel work at the Morwell power house, at a cost of £115,000.

MR. J. H. G. MONYPENNY lectured to the members of the Sheffield branch of the Association of Engineering and Shipbuilding Draughtsmen at the Montgomery Hall on November 18 on "The Romance of Steel."

MR. THOMAS VICKERS, organising secretary of the British Cast Iron Research Association, addressed a meeting of South Wales iron producers at Swansea recently and explained the Government's scheme of research in iron foundries.

A HARTLEPOOL report states that contracts for two liners for the Netherland Steamship Company have been placed with Continental firms. Their prices are reported to have been less by 20 per cent. than the lowest British quotations.

THE UNVEILING of the war memorials of the Institution of Mining Engineers and the Institution of Mining and Metallurgy by Field-Marshall Earl Haig took place last Thursday. The memorials are placed in the Library at Cleveland House, 225, City Road, E.C.1.

AN AMALGAMATION has been arranged between the engineering firms of George Kent, Limited, London and Luton, and J. Blakeborough & Sons, Limited, London and Brighouse, under the title of George Kent, Limited, and J. Blakeborough & Sons, Limited. The central sales offices will be at 199/200, High Holborn, London, W.C.1.

"THE PRODUCTION OF STEEL CASTINGS" was the subject of a paper by Mr. F. Darley (of Thomas Firth & Sons, Limited) at a meeting of the members of the Sheffield and District Branch of the Institution of British Foundrymen, at the Cutlers' Hall, Sheffield, on November 18. Mr. J. Watson (branch president) was in the chair.

SPEAKING at Wallsend, recently, Mr. Summers Hunter, C.B.E., chairman of the North Eastern Marine Engineering Company, said that while we were going to have a hard winter, and there would be unemployment difficulties to be faced, there were indications of a coming change for the better in the industrial world.

THE Wallasey Ferries Committee recommended the Council, at a special meeting, to accept the tender of Sir William Arrol & Company, Limited, of Glasgow, to construct the new floating roadway at Seacombe Ferry, and to complete the work in connection therewith for the sum of £85,616. The ultimate decision, of course, rests with the Council.

IT IS estimated by the executive of the Amalgamated Engineering Union that a reduction of about £50,000,000 will be made in the annual wages cost as a result of the ballot decision of the members of the engineering and shipbuilding unions to accept the withdrawal by instalments of the 12½ per cent., and 7½ per cent. Ministry of Munitions bonus.

In the report for 1920 of the General Adviser to the Government of Johore mention is made of the opening of an iron mine on the left bank of the Batu Pahat River, a mining certificate over 50 acres having been issued to a Japanese firm. The ore is mainly hematite, containing about 65 per cent. of iron, and there is sufficient ore in sight for five years' working.

Much satisfaction is expressed in the shipbuilding industry at Dundee by the re-employment of about 200 workmen of the Caledon Shipbuilding and Engineering Company, Limited, owing to the decision of the directors of the Holt Line, that work shall be resumed on the large steamer "Perseun," which is in course of construction by the Company, but which had been held up for some time.

Messrs. Clayton Wagons, Limited, Lincoln, have, it is understood, recently received orders for twenty third-class carriage underframes and bogies for the broad-gauge section of the East India Railway; for twenty-five carriage underframes, with bogies, for the metre-gauge lines of the Burma Railways, and 300 sets of wagon fittings for metre-gauge covered goods vehicles for the Bengal and North-Western Railway.

REPRESENTATIVES of the Federation of Steelmakers, Rolling Mills Proprietors' Association, and the Forgers' and Tilters' Association met workers' representatives at Sheffield last week, and proposed a reduction of 11s. 6d. a week for the men who are paid the consolidated shift war bonus of 45s. per week. The employers contended it should be reduced to 33s. 6d., the figure paid in the boilermaking and engineering industries. No decision was reached, and the conference adjourned.

RECOGNISING the desirability of forming an association to meet their academic and technical requirements, numerous representatives of the metallurgical and allied trades in the West Riding met at the George Hotel, Huddersfield, on Saturday last, when it was decided to form a society in promotion of these objects. This will be designated the West Yorkshire Metallurgical Society. Mr. T. E. Hull, Huddersfield, was elected as president; Mr. A. Hudson, Huddersfield, hon. treasurer; Mr. H. C. Dews, 17, St. John's Road, Huddersfield, hon. secretary; Messrs. G. France, J. R. Handforth, S. Gamble, F. Rawlinson (Huddersfield), A. Jackson, (Low Moor), F. Kilburn (Dewsbury), H. R. Pitt (Wakefield), and W. H. Pool (Keighley), committee.

Gazette.

MESSRS. N. H. NEALE and H. Radcliffe, stampers, piercers, etc., 29, Warstone Lane, Birmingham, trading under the style of Henry Radcliffe & Company, have dissolved partnership.

THE SHAREHOLDERS of the Nechells Metal Company, Limited, have decided to wind up the company voluntarily. Mr. J. W. Martin, 12, St. John's Road, Kate's Hill, Dudley, has been appointed liquidator.

MESSRS. R. O. ROBERTS, T. E. H. Jones, E. O. Roberts, and T. H. Jones, slag grinders, 10, Dale Street, Liverpool, trading under the style of the Western Counties Basic Slag Company, have dissolved partnership.

METALS DEVELOPMENT SYNDICATE, LIMITED, London. E.C.—It was resolved, October 31, confirmed November 15:—That the syndicate be wound up voluntarily. Mr. F. A. Crew, 20, Copthall Avenue, E.C., I.A., has been appointed liquidator.

TRADING AS THE Premier Sheet Metal Company, Messrs. H. Broadbent and W. Smith, Beever Street, Oldham, sheet metal workers, have dissolved partnership. Debts by the said H. Broadbent and Arnold Sutcliffe, of 35, Wallshaw Street, Oldham, now carrying on business as the Premier Sheet Metal Company, of Beever Street.

AT THE EXPIRATION of three months the names of the undermentioned companies will be struck off the Register of Joint Stock Companies, and the companies will be dissolved:—Dee Smelter, Limited; Highmeadow Iron Company, Limited; Holzer Steel Process Syndicate (United Kingdom), Limited; Kable Electrical Company, Limited; Kirkland Steel Foundry, Limited; Larran Engineering, Limited; Metal Deposition, Limited; Naval and Patent Light Steel Construction, Limited; Phœnix Iron Works, Limited; Wallace Griffin Electrical Company, Limited; and the Weardale Barytes and Mining Company, Limited.

Deaths.

MR. G. W. ALDRED, recently of C. A. Peters, Limited, engineers, Derby, has died at the age of 63.

MR. WALTER MACFARLANE, of Kelvin, Hollies Drive, Wednesday, died on November 19. The deceased gentleman was until quite recently principal of the Staffordshire Metallurgical College at Wednesbury.

MR. W. GAYTHWAITE, of the Forge House, Cleator, died recently. After being associated with the Whitehaven Hematite Iron and Steel Company, Limited, and S. & J. Lindow, owners of iron-ore mines, he acquired the business of the latter company. He was 69 years of age.

SIR FREDERICK ORR-LEWIS, BT., of Whitewebbs Park, Enfield, died recently at his villa at Cannes. For many years he had been the representative in Canada of the Vickers Company, and was largely instrumental in the establishment of Canadian Vickers, Limited, of which he was president.

MR. R. KILBURN, senior partner of the firm of Messrs. Richard Kilburn & Sons, textile machine makers, of the Perseverance Works, Elland Road, Leeds, died at his residence, The Close, Roundhay, recently, in his 80th year. The Hunslet Foundry was established about a hundred years ago by Mr Kilburn's father, on whose death his two sons, Richard and Frederick, succeeded to the business.